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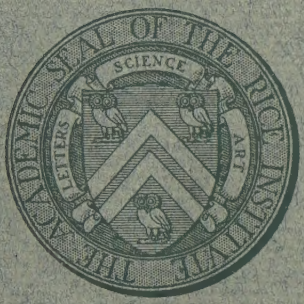

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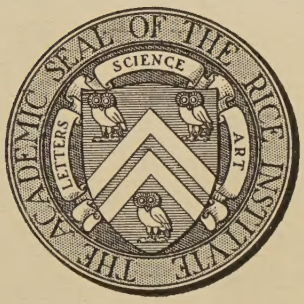

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PUBLIC LECTURES

I

ST. ISIDORE AND MEDIAEVAL SCIENCE

NEARLY twenty years have passed since I first crossed the threshold of Widener J and K, the Historical Seminary rooms of Harvard University, with a small group of inwardly disturbed, though outwardly self-assured, graduate students to begin Dean Haskins' advanced research course, designated in the Official Register as "An Introduction to the Sources of Mediaeval History." There I was to learn shortly the truth of Professor Laski's observation to the effect that the real intellectual discipline, imposed by the Dean's keen mind and forceful personality, caused the student "to have his mind turned upside down, to be driven back, by continuous questioning, against difficulties he either did not know or sought to avoid."[1] My memory is not entirely clear upon this next point, though I think I may safely assume an awkward attempt on my own part to conceal ignorance. At any rate, I recall the question well. It was probably the first heavy volley that Haskins ever fired at me: "How foolish was Isidore, and why?" The *why* was added characteristically as a caution against that weakness of human nature for making unsupported assertions. It was an eminently respectable question as I was to realize later with a certain feeling of pride that I had been chosen the one—or the first one, perhaps—to appear foolish that after-

[1] For footnotes see page 103 of this pamphlet.

noon in the attempt to answer it. However, a lasting impression had been made. My mind was to revert to this problem and to speculate upon it in many an idle moment during the intervening years, and at last this afternoon I feel that I may suggest some avenues of approach to the answer, though I am not yet promising to answer the question itself.

At a later day, it became abundantly clear that the mind of St. Isidore could not be estimated safely upon any superficial consideration, especially since the greatest authorities on the mediaeval period offer puzzling and contradictory views which often appear the product of short-sighted depreciation. None seems more unfair, largely because of what it leaves unsaid, than the criticism of the great author of *The Mediaeval Mind,* Dr. Henry Osborn Taylor, whose almost invariably sound and balanced judgments make the passage which I cite here all the more surprising. "By reason of his own habits of study, by reason of the quality of his mind, which led him to select the palpable, the foolish, and the mechanically correlated, by reason, in fine, of *his* mental faculties and interests, Isidore gathered and arranged in his treatises a conglomerate of knowledge, secular and sacred, exactly suited to the coming centuries."[2] This statement has done much to place Isidore in the poor light accorded him by subsequent text-book writers and to confirm his reputation for thin, dry, sterile, and jejune thinking. His vast encyclopaedic compilation, the *Etymologies,* is indeed, often cited as the prime exhibit of mediaeval inanity even by the professed friends and devotees of the Middle Ages. Thus, Dom Leclerc describes it as a vast lumber-room in which were stowed away all the cast-off clothes of antiquity,[3] and James Westfall Thompson refers to it as "a sort of museum of desiccated antiquities of the classica

era."[4] Carl Stephenson remarks upon the ridiculous contrast "between the book's lofty pretensions and its feeble performance,"[5] while Lynn Thorndike has the dry suspicion that its handiness and convenience "tended to encourage intellectual laziness and stagnation more than any anthology of literary quotations did."[6] After noting Isidore's lack of critical sense and poor record for veracity in their useful *History of Later Latin Literature,* Professors Wright and Sinclair bespeak their disapproval of the bad influence of this tome upon later centuries, since from it "learned and unlearned alike gathered unquestioningly the fruits of a very much decayed tree of ancient knowledge."[7] This judgment closes, however, in a happier mood by chiding us lest we make merry at Isidore's expense, and by asking us to remember that he was as industrious as those titanic laborers in the vineyards of scholarship, Boethius and Cassiodorus, and that "it was his misfortune to live at the end of a period when secular learning was disappearing."[8] Even Brehaut, the author of the only extended monograph on Isidore, who consistently presents the subject of his study in the best possible light, says that the *Etymologies* "furnish, so to speak, a cross-section of the débris of scientific thought at the point where it is most artificial and unreal."[9] Professor Laistner of Cornell strikes a higher note. He points out that "Isidore was a polymath whose literary labours touched every branch of human knowledge"[10] and that "it is easy to sneer at the *Etymologies* and to point to single items in the book which strike a modern reader as puerile,"[11] but goes on to observe that this compilation was a genuine achievement considering the inaccessibility of the source material and the scarcity of scholars able to comprehend these sources. Finally he states that Isidore's indulgence in etymological detail that is often fanciful and absurd "has tended to ob-

scure the substantial merits and accuracy of much of his information."[12] Haskins who was not given to answering his own questions contents himself by urging, "the very fact that Isidore was only a compiler gives him a representative quality which a more original work would have lacked."[13] Miss Waddell, who always rallies to the cause of unappreciated mediaeval worthies from the *rhinoceros indomitus,* Abélard, to Gerbert "with the light of the everlasting bonfire playing about his head,"[14] alludes in a satisfied manner to Isidore's "monumental common-sense."[15] In a footnote in his *Primer of Medieval Latin,* C. H. Beeson offers a sound and fair, albeit sly, extenuation of Isidore's eccentricity: "His influence was quite out of proportion to the intrinsic merit of his works. Many of his etymologies, however, are no worse than most ancient attempts and some modern ones to explain the origin of a word."[16] Finally we may close with the shrewd Christopher Dawson's comment that, "In spite of their lack of literary quality, writers like Orosius and Isidore of Seville, Cassiodorus and Gregory the Great, did more to shape the minds of later generations than many geniuses of the first order."[17]

In the face of such a diversity of opinion among modern specialists, we may risk several added questions: Did Isidore appear foolish to his contemporaries and immediate mediaeval successors, or is his foolishness a more recent discovery? Was he grossly superstitious, or merely lacking in resources of fact and data? Was he intellectually incompetent, or only struggling amid the thought currents of his time and so condemned to be the product of his age? The first question may be disposed of readily, when we consider that few scholars, if any, were more widely cited for reference purposes by later writers, and that fifty-four MSS of his *Etymologies* are still surviving outside Spain, together with 121

MSS of selections from the same work, all eloquent testimony of his eminence in the mediaeval world of letters. Indeed, Professor Rand has remarked that, "No better way could be found to an immortal and authoritative existence in the Middle Ages"[18] than to have been commended by St. Isidore. Also he was one of those towering figures, conspicuous in mediaeval times, whose names lent prestige to various works by virtue of false attribution. Isidore's pseudonymousness ranges from the famous *False Decretals* in canon law to various minor lyric poems. And W. P. Ker in his little book, *The Dark Ages,* provides a bit of final evidence in a line from the English version of the romance of the *Destruction of Troy* which he says "is as good an instance as could be found of (the saint's) popularity," at least among the half-learned—"And Ysidre in Ethemoleger openly tellis."[19] It is a simple line; even so, dictionaries and their authors seldom figure in popular fiction.

The other questions had best be considered perhaps against the background of the period. Surprisingly few details of Isidore's biography have been preserved, though Lecky quotes from the *De Rebus Hispaniae* of the sixteenth century Jesuit historian, Mariana, the customary charming and edifying tale, appropriate to every mediaeval saint, in this instance attesting the truth of the principle that constant exposure will wear away the most durable of materials. It runs in this wise:

> A Spanish boy, having long tried in vain to master his task, and driven to despair by the severity of his teacher [this reminds us of another literary gem, concerning the poet Horace and his master, Orbilius], ran way from his father's home. Tired with wandering, and full of anxious thoughts, he sat down to rest by the margin of a well, when his eye was caught by the deep furrow in the stone. He asked a girl who was drawing water to explain it, and she told him that it had been worn by the constant attrition of the rope. The poor boy, who was already full of remorse for what he had done, recognized in the reply a divine intimation. "If," he thought,

"by daily use the soft rope could thus penetrate the hard stone, surely a long perseverance could overcome the dulness of my brain." He returned to his father's house; he laboured with redoubled earnestness, and he lived to be the great St. Isidore of Spain (*gran doctor de las Españas*).[20]

This is an interesting anecdote and may throw some light on Isidore's later remarkable reputation for industry, though I hardly think it belongs in the same category with the Ciceronian dream of St. Jerome, as evidence for the necessity of divine intervention to guarantee desirable saintly habits. I do not think the compiler of a dictionary is a person who could have ever needed to be urged to work. However, returning to the veritable facts of his life, we know that he sprang from an orthodox Hispano-Roman family of Cartagena, that his younger years were spent under the tutelage of his famous brother, Leander, who, as bishop of Seville, played the leading part, together with King Reccared and Pope Gregory, in the conversion of Spain from the Arian heresy to the Catholic faith, and that he was born in about the year 570, lived through the heart of the Christian "Dark Ages," and died exactly thirteen centuries ago in 636, having succeeded Leander as bishop of Seville and become the most distinguished scholar of the Latin West. Thus, he was almost the identical contemporary of Mohammed whose fiery faith was destined to blaze across Spain and sweep away nearly every vestige of that Visigothic culture which Isidore had illumined. Also his youth and young manhood coincided with the closing years of Gregory the Great and Gregory of Tours. These three, Isidore in Spain, Pope Gregory at Rome, Gregory of Tours in Merovingian Gaul, together with the Venerable Bede in Anglo-Saxon England a little later on, were the brightest intellectual lights to shine over the dull wastes that stretch across two centuries and more from Boethius to Alcuin, or, to preserve the impression of aridity which has intrigued Professor Thompson, "the well

grows drier and the water worse as we advance from the fourth to the sixth century, and by 600, as Gregory of Tours confessed, it was low tide in western Europe."[21] The conditions of the time did not favor the creative intellect or complete comprehension of the classical masters. Hence Brehaut reminds us that physical reality was no longer apprehended through systematic observation but, instead, attention was concentrated upon the superior realities of the spiritual world.[22] And it is precisely at this point that we discover the clue which explains Isidore's inadequacy in the realm of natural science. His mind was attuned to the otherworldly mystery rather than the secrets of nature, although he seems to be free from the dark, unreasoning terrors and the hideous fear of hell that cast a dull veil of melancholy about the soul of Gregory. He displayed an interest in secular learning and the pagan authors, unusual in the age of the Pope who boasted that he spoke not according to the rules of grammar but as the spirit moved him, and who would have destroyed the Egyptians, not merely despoiled them. However, the writer of the *Dialogues* may be presumed to have been influenced by sentiments and considerations very different from those entertained by the compiler of an encyclopaedia. Nevertheless, in Isidore, too, there was the "upward glance" which distracted from the world and man, despite his interest in the antique wisdom.

Quite likely we need not tarry among Isidore's minor works, largely theological[23]: a volume expounding certain books of the *Old Testament,* the *Sentences* devoted to the nature of the Trinity and of the angels, his polemic against the Jews, *De fide catholica contra Iudaeos,* a book of scriptural allegories, a treatise on the duties of ecclesiastics, a strict monastic *regula,* and a devotional work, the *Synonyma* which has been called "a lamentation for the sorrows of the

world" after the manner of Job, with a *Chronicle* and a *History of the Visigoths* of little value, copied in the main from earlier histories. Besides, somewhat more secular in nature, there are the *Differentiae* in two books—*On Differences of Words* indicative of his etymological predilection, and *On Differences of Things,* as between angels, demons, and men, between angelic and human wickedness, between the grace of God and the will of man—, a cosmological treatise *On the Scheme of Creation,* including the spiritual as well as the material universe, the *Liber numerorum* on the magical properties of numbers, and an important exposition of the physical science of the time, entitled *De natura rerum.* But casting all these into obscurity was the monumental encyclopaedia, designated *Etymologiae* or *Origines,* which must be considered one of the most influential works, regardless of its specific merit, to fall within the purview of the student of the history of European culture, since it provided a large part of the informational content of scholarly thought for centuries in an especially concise, convenient, and accessible form. Isidore belonged to the age of manual, compend, and commentary, of glosses and annotations, of outlines, abstracts, epitomes, and epitomes of epitomes, in short, the text-book habit of mind, now inculcated so effectively in our modern secondary schools that it requires approximately four years for our universities to rescue our students from the "Dark Ages." The tabloid type of mind was dominant then as now, and it is probable that the demand for concentrated and predigested mental pabula remains a constant across the centuries from ancient Alexandria to modern New York, although this hardly excuses the scholar from falling a victim of it.

On the other hand, a much more respectable appearance may be placed on Isidore's labors, if we consider the real

utility of the *Etymologies* in providing a wide range of information for a time desperately in need of it, to say nothing of the pervasive, continuing influence which this compilation enjoyed through many subsequent centuries. Isidore belonged to a period in which a single mind could still hope to encompass the entire range of human knowledge in the fashion of Aristotle. Also such Roman authors as Varro and the elder Pliny had continued the tradition of collections of general encyclopaedic information, though their works were of narrower scope and of a more literary tone. Thus, Varro and Verrius Flaccus developed a curious literary science of marked antiquarian flavor which interested itself in grammar, word-derivations, philology, and poetic allusions, while Pliny's *Natural History* formed an extended scientific note-book and manual of miscellaneous matter that reached from the commonplace to the outer bounds of credulity and included such varied subjects as "geography, man and his inventions, animals, plants, vegetable products, medicine and medicinal plants, metals, pictures, colours, and gems."[24] Besides, a minor type of encyclopaedia for educational purposes, of which the *De nuptiis philologiae et mercurii* of Martianus Capella expounding the Seven Liberal Arts in elaborate allegory may serve as an example, gave emphasis to the tradition of compends of ordered information, and the alphabetical arrangement of material, introduced by Flaccus, established the conventional dictionary method of presenting topics, which added to convenience and conformed with the epitomizing habit of mind. It was the purpose of these encyclopaedists to provide an authoritative body of knowledge expressed in general terms, in the manner most easy of access and most easy of comprehension, not to extend knowledge through scientific inquiry according to modern ideas.

Thus, we find that Isidore stands at the center of a movement, presenting scientific matter in encyclopaedic form, which derives from Aristotle's *History of Animals,* Varro's *Antiquities,* Seneca's *Natural Questions,* Pliny's *Natural History,* the *Geography* of Claudius Ptolemy, the *Collectanea* of Solinus, the *De nuptiis* of Martianus Capella, and a treatise by Cassiodorus on the liberal arts, and which is continued in the *De natura rerum* of Bede, the *De universo* of Hrabanus Maurus, the *De mensura orbis terrae* of Dicuil, John the Scot's *De divisione naturae,* the *De imagine mundi* (*ca.* 1100) attributed to Honorius of Autun, the odd work of Bartholomew of England *On the Properties of Things* (*De proprietatibus rerum*), Alexander Neckham's *De naturis rerum,* the mighty *Speculum maius* of Vincent of Beauvais, even to the *Margarita philosophica* of 1503, while much of the geographical information in the *Otia imperialia* of Gervase of Tilbury, the *Chronicle* of Otto of Freising and the *Liber floridus* of Lambert of St. Omer is obtained from Isidore. By piling his debtors like Pelion on Ossa, we begin to appreciate the measure of our man and his significance for the history of learning. However, this is all a scholarship of borrowing. Very much as the mediaeval chroniclers built up their narrative by continuation, each standing on his predecessor's shoulders, so the structure of mediaeval science was erected by a cumulative process. Robert of Torigni continued Sigebert of Gembloux, who continued Prosper of Aquitaine, who continued Sulpicius Severus and St. Jerome, who continued Eusebius Pamphili, who continued Josephus, who stood on the rock of the *Old Testament,* thereby perfecting an historical record which should stand unchallenged from Creation to the Judgment Day. Likewise, Vincent of Beauvais and Bartholomew of England in the great thirteenth century, as well as Hrabanus in Carolingian days, bor-

rowed from Isidore, who copied from Solinus, who abstracted from Pliny, who appropriated from Aristotle, who sent his students to the far corners of the earth, gathering his data. The ultimate credit for some measure of the valid science, available in western Europe at the dawn of the modern period, belongs to those long-forgotten anonymous students of the "Master of Those Who Know." In the light of such respectable and saintly borrowing, the sin of plagiarism reduces to a pale, thin, academic discussion unworthy of scholars and gentlemen. It was the students then as now who were the true contributors to and sufferers for the advancement of learning. A brief example in illustration of this tendency may be found if we take the case of the salamander. Like the small boy today, mediaeval men were intrigued by Natural History, especially animals [that is why they loved their Pliny so]; hence we may assume this example is typical of the continuing process, whereby antique science was perpetuated. Aristotle in his *History of Animals* in the fourth century B.C. said: "Now the salamander is a clear case in point, to show us that animals do actually exist that fire cannot destroy; for this creature, so the story goes, not only walks through the fire but puts it out in doing so."[25] The story has grown in the telling with Isidore, though he is really only abstracting from Pliny:[26]

> The Salamander is so called because he prevails against fire. Among all venemous creatures, he is the mightiest; others kill individuals alone, but the salamander kills several at once. If he crawls upon a tree, he taints all the fruit with his poison, and they who eat of it perish; or if he falls into a well, they who drink therefrom die. He alone of all animals, fighting against fire, extinguishes it; for he lives in the midst of flames, neither harmed nor conquered by them, and not only is he not burned, but he puts out the fire.[27]

When we come to Bartholomew of England in the thirteenth century, the story is shorter but it has also grown: "The sala-

mander quencheth the fire that he toucheth as ice does, and water frozen."[28]

To those who are curious to know more regarding the specific contents of the *Etymologies* and the way in which the various topics are treated, I must state regretfully that no translation from the Latin text exists save for selections in Brehaut's monograph, and that in many places the work is almost untranslatable, owing to the necessary play upon words involved in establishing their derivations. The structure of the treatise consists of twenty books, devoted to the seven liberal arts, medicine, law, chronology, the Scriptures, the offices of the Church, God, the angels and saints, the alphabet, languages, races, men, monsters and animals, the universe, the earth, stones, metals, plants, architecture and surveying, warfare, games and pastimes, ships, dress, food and drink, even household furniture. Thus, the work is very comprehensive, the *Encyclopaedia Britannica* of the Middle Ages; and the longest book is on animals. I shall try to give a few samples from the section on chronology which is subdivided into minutes, hours, days, months, years, *lustra* (periods of five years), centuries, and ages. Of days, he says:

> The day is the presence of the sun, or the sun above the earth, just as night is the sun under the earth. Whether it be day or night depends upon whether the sun be above the earth or beneath it. The true day is twenty-four hours in length, so that day and night include within their span, in accordance with the revolution of the heavens, the interval from sunrise to sunrise. Incorrectly, however, a day is the space from sunrise to sunset. There are, then, two parts of the day, day and night; day is, to be sure, twenty-four hours in length, but it is also a space of twelve hours.[29]

You can see the subject is becoming involved; it becomes positively complex, when he explains the days of the week, so that the battle is on between Saturday, the Sabbath, and Sunday, the Lord's Day, for primacy in beginning the week.

Next he tackles morning, noon, and evening, with much esoteric etymology, but this is all naught compared with the recondite distinctions between today, tomorrow, yesterday, day before yesterday, and day after tomorrow (*hodie, cras, hesternum, pridie, perendie*).[30] If you do not think this is difficult, try writing an essay on these subjects yourself. After this effort, he examines the week, and like one of my colleagues who stimulates his students on occasion by announcing that reading will be assigned hebdomadally, Isidore presents the topic under the caption *De hebdomada* and faces the prospect of Greek derivation cheerfully, if not competently.[31] The ages are interesting and may be distinguished in two ways, as in the ages of man, infancy, youth, and old age, or as in the ages of the world of which the first extends from Adam to Noah, the second from Noah to Abraham, the third from Abraham to David, the fourth from David to the Captivity of the Jews in Babylonia, the fifth from the Captivity to the Advent of the Saviour in the flesh, and the sixth in which we now live, continuing thence to the end of the world and the Last Judgment.[32] Then follows a detailed outline of historical events arranged in a sort of chronological chart or table, so that each is included within its appropriate age.

There remains still the matter of Isidore's criteria in the selection of his material. For the most part, he accepts St. Augustine's principle that secular knowledge must conduce to Christian ends and approves the patristic practice of utilizing the pagan authors in the interest of Christian truth. However, Isidore does not disparage or reject his classical heritage; he merely adapts it to the lower intellectual level of the seventh century, but in this process of adjustment the antique habit of thought is transformed to meet Christian needs. Brehaut points out in this connection that Pliny wrote

a survey of "what was known," while Isidore wrote a survey of "what ought to be known." The relative scientific objectivity of the ancient writer is replaced by an authoritarian formulation, resting upon dogmatic preconceptions, though it is only fair to add that Pliny's credulity is sometimes such that Isidore could have imagined nothing more unlikely. Hearsay may be as misleading as revelation or the authority of a book. Finally, Isidore faced the difficult problem of selecting from a wide range of material, and the resultant eclecticism led to incoherence. However, since his inconsistency was based upon authority, he was never called upon to face the question of intellectual integrity and so easily became an authority himself. Had he questioned his sources, he would have lost standing forthwith. But as an authority, he remained a soundly catholic, conservative scholar, not to be mentioned in the same breath with that line of dangerous radicals, leading from Eriugena, Gerbert, and Abélard, through the Averroists and Siger de Brabant, Michael Scot, Roger Bacon, Leonard of Pisa, Raymund Lully, and Arnald of Villanova, to Copernicus, Giordano Bruno, and Galileo. Isidore's science was "good" science, deductive and authoritative by grace of God; theirs was "bad" science, induced from nature in some cases and only as sound as human understanding; to them fumes of sulphur clung faintly, and about them hung a lurid glare. In this connection, I am tempted to quote a statement from Lecky's *History of the Rise and Influence of Rationalism in Europe* that during the Middle Ages, "Innovation of every kind was regarded as a crime; superior knowledge excited only terror and suspicion. If it was shown in speculation, it was called heresy. If it was shown in the study of nature, it was called magic."[33] Nevertheless, this attitude lingers still at the present time. Not so long ago I read an editorial in which the writer

sneered at the views of Einstein, on the ground that the editor himself could not understand them, thereby making the measure of Einstein's genius the degree of his own comprehension.

If we attempt to analyze and account for the peculiar cast of mind apparent in Isidore, we must turn back some centuries to the Academy where Plato advanced his doctrine of absolutes in which ideas are regarded as objective in character and antecedent to things. These ideas rise from the concrete to the general until at the pinnacle of his thought-structure, we reach certain ultimate concepts or universals, as "the Good, the Beautiful, and the True," which are highly abstract and comprehensive and which represent final reality. It was an axiom of the Realist school of the later Middle Ages that *universalia sunt ante res;* ideas pre-exist things, the world, and man. In other words, reality consisted in certain transcendental concepts which are immaterial and metaphysical by nature, and, therefore, not susceptible of any scientific physical analysis. Next let us ask: What happens to things in such thought processes? What is the nature of *res*? In short, we may reply that the natural universe and everything in it become a reflection and a shadow of a mental and spiritual realm which is ultimate and real. And because these ideas are a final goal and essential reality, they are complete in themselves, ideal, perfect, and absolute in authority. To such an extent was the mediaeval mind committed to this view of reality or, as certain critics might say, charmed by its own creations that some thinkers denied the perceptions of the senses willingly, when their evidence ran counter to accepted principles. I shall not confuse the matter by entering into the discussion of the relative ranks or grades of ideas, for we have ideas about ideas as well as ideas about simple things. Years ago a fraternity brother took his doc-

torate in Philosophy and centered his dissertation more or less about this problem. He wrote on the nature of *res* or "the thing," and became such an intellectual contortionist as to confuse me about every or any *res* thereafter.

However, we must beware of the misconception that mediaeval men went about ever-conscious of their debt to Plato, for, while the typical mediaeval habit of mind was Platonist, the men of the Middle Ages were largely unaware of Plato and Platonism, or, as Friedell puts it, Plato merely taught this theory of ideas whereas the Middle Ages lived it.[34] The Platonism of the Middle Ages was not an academic or a scholastic Platonism; in fact, Plato was not widely read throughout that period, save, perhaps, for the *Timaeus,* a metaphysical treatise which hovers between mind and matter. His discursive style and dialogue form were not attractive in an age devoted to compend and manual, while the text-book character of Aristotle's writing was fitted exactly to the mental habits of the time. Whether you are reading the *Poetics* or the *History of Animals* Aristotle sticks to his topical arrangement with main headings and subheadings in perfect outline, but Plato writes in a literary manner, compelling his reader to seek his meaning. Thus, the form of Aristotle's thought with its ordered learning is much closer to that of the mediaeval encyclopaedists and commentators; yet the color, atmosphere, and substance of the mediaeval mind, as a whole, are predominantly Platonic.

It is obvious that, since the Middle Ages did not become acquainted with Plato through his books, the channels through which his attitudes and views flowed down into the later time must be traced back to other sources. There is the direct Christian channel, proceeding from St. Paul as exemplified in the Fifteenth Chapter of First Corinthians where the distinction between the natural body and the spiritual body is

expressed in terms, readily understandable in the light of the Realist philosophy and its doctrine of objective universals. But more significant for the history of science is the murky, sluggish, devious current of Neoplatonism, which falls as off a precipice from the transcendental realms that lie beyond reason to lose itself in the stagnant swamps of magic and superstition. Yet, at its best, Neoplatonism retained the exalted idealism of Plato and his disinterest in material things, so that it underlies both the otherworldly motive and the ascetic impulse which are intrinsic in the mediaeval soul. On the other hand, in the Neoplatonic system the ultimates which are less sharply formulated in Plato's teaching are perceived in a central unifying principle, an absolute comprehensive Unity, which passes by emanation down to the *Nous* or perfected universal Mind and so through the World-Soul to the souls of men. In its extreme manifestation, asceticism resulted in a contempt of the flesh, an abhorrence of matter, and a disparagement of empirical knowledge, fatal to the development of a sound objective and inductive scientific method. The abandonment of the world of particular phenomena was accompanied by the adoption of purgative measures intended to lead man upward through ever more refined and perfect stages until his soul was fit to know the Absolute Intelligence, the Ultimate Unity, or, let us say, to know God. These last steps could not be achieved by any exercise of reason but by a mystic process, a final leap into the unknown, an ecstatic emotional experience in which knowledge is attained by agencies that lie beyond the imperfect senses and reason in what Taylor terms the sphere of the *suprarational.* The Neoplatonist metaphysics with its doctrine of discarnate and incorporeal mediate intelligences or *daemones* made possible an eventual hierarchy of mind and spirit, extending from the material world to the Absolute.

In its Christian application at the hands of Dionysius the Areopagite (the pseudo-Dionysius), this assembly of mediators blossoms forth in the graded ranks of the Celestial Hierarchy, arranged in nine orders: Angels, Archangels, and Principalities; Powers, Virtues, and Dominations; Thrones, Cherubim, and Seraphim; while to each order is assigned its specified task. Thus, it was allotted to the highest order of the Seraphim that they should "veil the face and feet of God." And in the Absolute One, the Universal Immanence, it is not hard to discern the Triune God.[35] From these beginnings, St. Thomas constructed his theory of angels as incorporeal beings who think only in terms of universals or, at least, comprehend the particular only through the universal, whereas man's limited intelligence must deal with particulars alone or, at most, comprehend the universal dimly through the particular. It must be noted that the psychology of the angels is developed soundly from his fundamental premises by deductive logic, but it does not demonstrate the objective existence of angels following observational modes of approach.[36] The metaphysical method shows that angels are intelligible and possible, but does not prove that they exist in any forms satisfactory to natural science, since, indeed, by definition they cannot have any tangible, material actuality, and, hence, cannot be inspected or dissected in a laboratory. In the same way, disembodied spirits become credible or, at least, plausible, such as we find in the legend of the priest of Isis who declared to Plotinus that he could raise up the spirit of Plotinus himself in visible form which he proceeded to do after the appropriate invocation with the singular result that "Plotinus stood face to face with his own soul."[37] Of course, I am not asking you to believe that this tale is necessarily true, nor can I explain how an immaterial spiritual substance may become visible.

Nevertheless, the implication of these beliefs is significant for the history of science. A habit of mind appears, highly favorable to the idea that spirits or superior powers may be utilized or invoked to control matter and nature. Here men do not attempt to investigate nature, only to control her through the proper occult formulae. This strange mental climate belongs to the realm of magic and theurgy.

The problem of magic is too confused and complex to consider in brief space. However, the essential feature of magic appears to me to consist in a failure to comprehend natural causation. Instead, it seeks "short-cuts" into the supernatural to explain and to produce the natural, because it considers that the forces or powers which occasion nature lie outside and above nature. There is no clear conception of the scientific relation of cause to effect within the material world, so that false causes are attributed constantly to the most obvious phenomena. Under such circumstances, it became easy for St. Isidore to regard words as "transcendental entities,"[38] similar to the ideas in Plato's scheme of thought. Thus, words hold much the same place in the economy of Isidore's thought as universals among the later Realists. They are objectively existent and independently efficient. In the same way, St. Augustine's theory of number dissolves into number mysticism, providing "paths of intelligence" through the universe, material and immaterial.[39] According to such a doctrine of absolutes, Isidore's *Liber numerorum* which "tells the qualities and mystical significance of every number from one to sixteen, and of the chief ones between sixteen and sixty" becomes comprehensible, if not convincing, and is certainly no mere foolishness but posited on a definite philosophy. I cannot agree with Taylor apropos of this work that it is difficult to find "an apter instance of an ecclesiastical writer elaborately exploiting the most foolish state-

ments that could possibly be found in the writings of a great predecessor."[40] Nor can I go quite as far as Thorndike who says that we have only an example of "mental magic and pious 'arithmetic'," combining the mysterious properties of numbers and words,[41] when Isidore defines the *modius* in his *Etymologies* as follows:

> The *modius* is so-called because it is of perfect mode. For this measure contains forty-four pounds, that is twenty-two *sextarii*. And the reason for this number is that in the beginning God performed twenty-two works. For on the first day He made seven works, namely, unformed matter, angels, light, the upper heavens, earth, water, and air. On the second day only one work, the firmament. On the third day, four things: the seas, seeds, grass, and trees. On the fourth day, three things: sun and moon and stars. On the fifth day three: fish and aquatic reptiles and flying creatures. On the sixth day four: beasts, domestic animals, land reptiles, and man. And all twenty-two kinds were made in six days. And there were twenty-two generations from Adam to Jacob—And twenty-two books of the *Old Testament*—And there are twenty-two letters from which the doctrine of the divine law is composed. Therefore in accordance with these examples the *modius* of twenty-two *sextarii* was established by Moses following the measure of sacred law.[42]

Brehaut seems to me to be correct when he says that the dictionary method of Isidore in the *Etymologies* is based not on mere convenience alone but upon philosophic grounds as well, and that the weakness of this method consists in an avoidance of "consecutive thought."[43] Isidore's thought does not follow through. In other words, it neglects or does not perceive the fundamental relation of "cause and effect"; hence his treatment is magical, not scientific in the best sense. But it is not foolish.

Mediaeval science, then, regarded nature as the result of an absolute and superior power which revealed itself in special ways, and allegory played its part in causing this science to be organized on a basis of mechanical correlations which were established by artificial analogy, not by logical analysis. The mediaeval mind was satisfied with surface relationships among disparate data, whereas the tendency of

modern thinking is toward the establishment of an organic synthesis of such material. We must remember that mediaeval thought began from a pole opposite to that of the present day, as, for example, when we find moral and mystical meanings attached to the letters of the alphabet or to animals, metals, colors, and gems. Also the attempt is made to account for the material universe by processes of reasoning, not observation, as when we are told that the earth, being round and in a circle, has neither beginning nor end. In accordance with these tendencies, mediaeval scientific method becomes a search for the *unique* rather than the *typical,* and *analogy* is preferred to *analysis*. Such casual mechanical correlation and mere superficial resemblance, lacking organic significance, led to the doctrine of correspondences which was accepted as valid proof. We have already seen an example of this in the *modius* where Isidore places great weight upon certain coincidences involving the number *twenty-two*. However, the analogical approach is as fundamental as the acceptance of the objective existence of ideas, universals, and their appropriate discarnate spirits or intelligences. Theoretical physics begins with the four ultimate elements (fire, air, earth, and water), themselves sometimes regarded as derived from a *prima materia* or *quinta essentia* still more ultimate. The four kinds of matter in the physical universe are based upon these elements and stratified according to the principle of weight, while each stratum is inhabited by suitable creatures: the fiery heavens, by angels; the air, by birds and demons; the water, by fishes; the earth, by the animals and man. These four elements may be transmuted from one to another through the four possible combinations of the basic qualities (hot and dry, hot and wet, cold and wet, cold and dry). Thus, ice (cold and dry) becomes water (cold and wet); this becomes steam (hot and wet)

which dissolves into air (hot and dry).[44] Physics and chemistry are simple enough, if you know the proper equations, although this arrangement had its complexities in the mediaeval pharmacology when you prescribed a remedial compound according to the *degrees* or relative proportions of the several qualities of its components. Sugar, for instance, is cold in the first degree, warm in the second degree, dry in the second degree, and moist in the first degree. Mediaeval science is a seamless garment, and medicine is associated with physics. By analogy man is the universe writ small, and an exact parallel exists between man and all his parts, and the structure of the universe. Thus, six hundred years later, Robert Grosseteste, arguing in exactly the same way, declared that man, like the world itself, is compounded of the four elements: his flesh is earth; his blood, water; his *spiritus,* air; his vital heat, fire.[45] This curious doctrine of the microcosm and the macrocosm made possible a visual representation in the anatomical or astronomic man who still remains as a mediaeval survival on the front page of our modern almanac. The Humoral Pathology, based on the four cardinal humors (black bile, yellow bile, blood, and phlegm), was developed by a correlation with the four ultimate elements and the four basic qualities, so that health depended upon the right balance or blending of these humors.[46] This, in turn, made possible further permutations and combinations in the medical equations. Geography fell into line with the quarters of the compass and the seasons of the year, and biology with the four ages of man. It was no coincidence surely that, when the bodies of the *three magi* were exhumed at Milan in 1164, as Robert of Torigni tells us, one seemed to be fifteen years of age, the second thirty, and the third sixty.

Throughout mediaeval science is an integrated nexus of

ideas resting upon ultimate universals. Consequently it is deductive and authoritative in character, establishing its proof by dialectic, not inductive and analytical, although it is observational to the extent that it notes analogies and seeks for them. Even history, lacking an adequate perspective of the past, yields to the analogical method by adopting the hexameral chronology of the six ages, corresponding to the six days of Creation. Brehaut has suggested that the mediaeval scientist was fascinated by the doctrine of the creation much the same as a modern scientist by the doctrine of evolution. He means that each of these theories may serve as a decisive point of departure or a sign pointing the way toward a path fruitful for further speculation. The creation appeared a most significant scientific fact, because it was the precise "point at which the natural emanated from the supernatural."[47] Also the supernatural world was the demonstrable and real; its phenomena alone possessed order and validity. On the other hand, the material universe was relatively unknown and unknowable, since no importance could be attached to the faulty evidence obtained through mere sense-perception.[48] Elsewhere Brehaut makes another important statement regarding the remarkable coherence of the mediaeval system of science:

> [Mediaeval thinkers] were firmly convinced of the solidarity of the universe; they felt its unity much more strongly than they did its multiplicity; what we regard as separate kinds of phenomena and separate ways of viewing the universe they regarded as of necessity closely inter-related. There were no categories of thought that were for them mutually exclusive; they carried their ideas without hesitation from the material into the immaterial, and from the natural into the supernatural. No conception established in one sphere seemed impertinent in any other. It was this state of mind that enabled the mediaeval thinker to take such erratic leaps from one sphere of thought to another without any feeling of uncertainty or any fear of getting lost.[49]

In the end, it must be borne in mind that mediaeval science is always *science* in its broadest literal sense of organized

knowledge regardless of whether the knowledge rests upon authoritative statement or observed fact. As we have seen, the encyclopaedic approach, authoritarian and deductive from accepted principles and standard subject-matter, is characteristic of the Middle Ages, whereas the experimental method, based on induction from observed and controlled data, leaves during the same period only vague and occasional traces to serve as harbingers of the modern age. Nevertheless, curiosity seems to be a quality of mind that, fortunately for human progress, is at no time wholly dead. Such men as Adelard of Bath, the Emperor Frederick II, and Roger Bacon continued from time to time to question, to examine, and to experiment, though Henry Osborn Taylor points out that Bacon is never entirely clear about the nature of the *scientia experimentalis* which he had learned from the amazing Master Peter of Maharncuria (Maricourt)—whether it was a science in its own right and an end in itself that could test the soundness of the conclusions in all the other sciences or whether it was "a means and method universally applicable to all scientific investigation" in the Aristotelian sense.[50] But there was no doubt of deliberate method and rigid control in Frederick's experiment to determine the original tongue of man by secluding from all hearing of human speech two infants who had not yet learned to talk, until he could learn whether they would speak Hebrew spontaneously which seemed probable, or whatever other less likely circumstance might ensue. It is an unimportant epilogue to note that the children died before the completion of the experiment.[51] It is, indeed, not inaccurate to say that mediaeval science had always been observational in its search for analogies and experimental, in some measure, in its attempt to control nature, as in magic and alchemy; yet these exceptions do not vitiate the general principle that the

primary purpose of that science was the *construction* of *a* universe rather than *investigation* of *the* universe.

Mediaeval research remained at all times very largely research in books, and the problem of going out to nature or back to books, if it arose at all, was settled by the cloistered scholar who went back to books. An amusing, though pointed, illustration is given by Lewes in his *History of Philosophy* concerning a mediaeval student who "having detected spots in the sun, communicated his discovery to a worthy priest. 'My son,' replied the priest, 'I have read Aristotle many times, and I assure you that there is nothing of the kind mentioned by him. Go rest in peace, and be certain that the spots which you have seen are in your eyes and not in the sun.' "[52] However, the story seems less ridiculous, when we recall that the Ptolemaic theory constructed a universe which was mathematically true to its hypotheses and was demolished only when the burden of accumulated observed evidence to the contrary was too great for tradition to resist. Similarly modern mathematical physics or astrophysics constructs our universe from the point that it leaves observed data and begins to infer the unseen. The form of modern thought differs from that of the Middle Ages as we have noted; yet there may not be such wide variance between truth in the guise of an angel or *universal,* and truth expressed in a mathematical symbol or Dirac's non-observable particle of negative mass (let us say), as Eric Temple Bell might lead you to suppose in his recent frantic *Search for Truth* which he finds "bogged" in the mediaeval morass.[53] He might do well to consider an observation once made by Ferdinand Lot that "mathematical speculation, wherein the mind wanders through infinity without ever meeting an obstacle or attaining control over facts, presents certain analogies with metaphysical speculation. Its processes and

solutions cast the soul into an ecstasy, almost pathological. Discovery by the power of reason alone leads to the belief that by juggling with formulae, one can penetrate the secrets of nature and submit them to the will of man. Thoughtless admiration for mathematics supports or reintroduces the mentality of magic."[54] This, too, is extreme, sardonic, and somewhat facetious; possibly both critics are mistaken. Perhaps the one should seek the peace of the Holy Grail and the inner vision of Parzival, while the other should study more mathematics. In the end, it seems best to say that, when the infinite extent of the realm of learning is perceived and taken to heart and mind, we cannot longer regard any human knowledge or the results of any investigation as final whether they eventuate in the rigid mechanical determinism of recent science, in the mediaeval resort to providential explanation, or in the worship of *Tyche,* the Greek goddess of "gambler's choice" or utter chance. Viewed in perspective, can we assert that the universe of Einstein will be lasting, whereas the universe of Ptolemy has passed away, or shall we assume that we must go on constructing universes as long as science shall endure, all equally true and all equally non-existent?

But, since Providence reigned supreme in the Middle Ages, a concluding word must be spoken of her exalted expression in mediaeval allegory and symbolism. Professor Rand has remarked that, when St. Ambrose read a passage from the *Scriptures,* he read it not merely once at a time, but four times at a time, "literally, morally or tropologically, allegorically or mystically, and anagogically" in accordance with mediaeval canons of scriptural interpretation.[55] Likewise, when mediaeval man read the Book of Nature, he had no eyes for the beauty depicted therein, but sought secret hidden meanings and saw only a high symbolic and sacramental

purpose. To be acceptable natural beauty must be interpreted; she must be helped to rise above herself. Otherwise she was a thing to be shunned as the tempter's snare set in lurking to catch the unwary traveler along the path of life. St. Benedict established that mighty fortress of God and sacred learning, the monastery of Monte Cassino, in an isolated place of rare beauty midway between Rome and Naples, overlooking the countryside. Here he looked in on himself and down on the world (*inspexit et despexit*). Nature was not to interfere with the soul's salvation. Much later and more surprisingly, Petrarch, sometimes called not altogether correctly "the first of modern men," while standing on a mountain-top, desires to view the beauty of the scene below. Then, remembering his St. Augustine as he looks, he recalls that Augustine would have him search his own heart. However, though there was no place for the beauty of nature in most mediaeval religious literature, certain knowledge of nature might edify and show forth God's purpose unto men. "Spiritual truth and moral truth transcended the truth of material facts," and "Natural science was, indeed, concerned with the lowest and faintest form of reality, namely, the material world; [yet] even material things had their spiritual implications, and because of this were worthy of an orderly survey."[56] In these words Brehaut finds a justification in the mediaeval scheme for the study of the world of phenomena and matter, for an examination of the particular, the concrete, and the disparate. Nevertheless, the mediaeval mind is ever painfully conscious of the untraversable abyss that separates man's evanescent and transitory home below from that world without end which was promised as the ultimate reward of a truly contrite heart. These two realms were separated by the irrefragable judgment of their creator, so that no earthly

wisdom or knowledge could ever bridge the gap, opened by Adam's sin,—a judgment that could be shaken only by a miracle of saving grace. However, to the eyes upturned to God through love of Jesus was granted a holy vision that revealed even the gross world as a mystic sacrament with virtue which could save. These mysteries were expounded most fully by Hugh of St. Victor who presents his theory of the universe in a great treatise on the Sacraments.

> For our purpose is to treat of the sacrament of man's redemption. The work of creation was completed in six days, the work of restoration in six ages. The latter work we define as the Incarnation of the Word and what in and through the flesh the Word performed, with all His sacraments, both those which from the beginning prefigured the Incarnation and those which follow to declare and preach it till the end.[57]

Thus, the earth, man and all his works, and all human knowledge combine to illumine the hidden road and join in the miracle whereby the impassable is passed. In this labor of love Isidore shared in his humble way. The degree of his foolishness can be measured only in terms of the quality both of the soul and of the mind of his critic. I have neither answered the question with which I began nor have I left it unanswered. Under the long evening light of Eternity, the words of St. Paul carry across the mediaeval centuries admonishing us that the wisdom of this world is but foolishness in the sight of God, and amid these Gothic shadows the voices of the skeptics, reiterating their petulant query "What is the Truth?" sound thinly, attenuating into empty silence, unconvincing and disregarded. And beneath the all-embracing majesty of God the world and its creatures stand for one brief moment of history, transfigured by His Glory.

Floyd Seyward Lear.

NOTES

[1]Cf. Harold J. Laski, *The Dangers of Obedience and Other Essays* (New York: Harper, 1930), pp. 102, 110, 141.

[2]Henry Osborn Taylor, *The Mediaeval Mind* (4th ed., New York: Macmillan, 1925), I, 103.

[3]Ferdinand Lot, *La Fin du Monde antique et le Début du Moyen Âge* (Paris: La Renaissance du Livre, 1927), p. 330, quoting Dom H. Leclerc, *L'Espagne chrétienne* (Paris, 1910), p. 319: *"grenier où il a remisé la défroque de l'Antiquité."*

[4]James Westfall Thompson, *The Middle Ages, 300–1500* (New York: Knopf, 1931), II, 800.

[5]Carl Stephenson, *Mediaeval History: Europe from the Fourth to the Sixteenth Century* (New York and London: Harper, 1935), p. 220.

[6]Lynn Thorndike, *A History of Magic and Experimental Science during the First Thirteen Centuries of Our Era* (New York: Macmillan, 1923), I, 623.

[7]F. A. Wright, and T. A. Sinclair, *A History of Later Latin Literature from the Middle of the Fourth to the End of the Seventeenth Century* (London: Routledge, 1931), p. 119.

[8]*Ibid.*, p. 121.

[9]Ernest Brehaut, *An Encyclopedist of the Dark Ages: Isidore of Seville* (New York: Columbia University Press, 1912), p. 16.

[10]M. L. W. Laistner, *Thought and Letters in Western Europe: A.D. 500 to 900* (New York: Dial Press, 1931), p. 89.

[11]*Ibid.*, p. 92.

[12]*Ibid.*, p. 93.

[13]C. H. Haskins, *The Renaissance of the Twelfth Century* (Cambridge: Harvard University Press, 1927), p. 304.

[14]Helen Waddell, *The Wandering Scholars* (Boston: Houghton Mifflin, 1927), p. 67.

[15]*Ibid.*, p. 165.

[16]C. H. Beeson, *A Primer of Medieval Latin* (Chicago: Scott, Foresman, 1925), p. 136, n. 1.

[17]Christopher Dawson, *The Making of Europe: An Introduction to the History of European Unity, 400–1000 A.D.* (London: Sheed and Ward, 1932), p. 98.

[18]E. K. Rand, *Founders of the Middle Ages* (Cambridge: Harvard University Press, 1928), p. 63.

[19]W. P. Ker, *The Dark Ages* (Edinburgh and London: Blackwood, 1923), p. 138.

[20]See W. E. H. Lecky, *History of European Morals from Augustus to Charlemagne* (New York, 1887), II, 204–205.

[21]J. W. Thompson, *op. cit.*, II, 800.

[22]E. Brehaut, *op. cit.*, p. 16.

[23]The best account of Isidore's life and works may be found in Max Manitius, *Geschichte der Lateinischen Literatur des Mittelalters* (*Erster Teil: Von Justinian bis zur Mitte des Zehnten Jahrhunderts*) (Munich, 1911), pp. 52–70. Also see M. L. W. Laistner, *op. cit.*, pp. 89–94; E. Brehaut, *op. cit.*, pp. 15–34; J. E. Sandys, *A History of Classical Scholarship from the Sixth*

Century B.C. to the End of the Middle Ages (2nd ed., Cambridge: University Press, 1906), I, 456–458.

[24] See article on "Education" by J. W. Adamson, in *The Legacy of the Middle Ages* (Oxford: Clarendon Press, 1926), p. 278.

[25] Aristotle, *Historia animalium* (trans., D'Arcy W. Thompson, Oxford, 1910), v., 19, 15.

[26] Pliny, *Naturalis historia* (ed., D. Detlefsen, Berlin, 1871), xxix, 4, 23. See *The Natural History of Pliny* (trans., J. Bostock and H. T. Riley, London, 1855), xi, 116 (Vol. III, p. 98): "The animals which feed upon poison have been already mentioned. Some of them, which are harmless of themselves, become noxious if fed upon venomous substances. The wild boar of Pamphylia and the mountainous parts of Cilicia, after having devoured a salamander, will become poisonous to those who eat its flesh; and yet the danger is quite imperceptible by reason of any peculiarity in the smell and taste. The salamander, too, will poison either water or wine, in which it happens to be drowned; and what is more, if it has only drunk thereof, the liquid becomes poisonous. The same is the case, too, with the frog known to us as the bramble-frog. So numerous are the snares that are laid in wait for life!" This passage affords an interesting contrast with the statement made by Aristotle. In Isidore's compend the *fire* tradition of Aristotle has been combined with the *poison* tradition of Pliny.

[27] Isidore, *Etymologiae sive origines* (ed., W. M. Lindsay, Oxford, 1911), xii, 4, 36.

[28] Bartholomaeus Anglicus, *De proprietatibus rerum* (trans., Berthelet), xviii, 92.

[29] Isidore, *Etymologiae,* v, 30, 1–2.

[30] *Ibid.,* v, 30, 18–22.

[31] *Ibid.,* v, 32, 1.

[32] *Ibid.,* v, 38, 5.

[33] W. E. H. Lecky, *History of the Rise and Influence of Rationalism in Europe* (London: Longmans Green, 1913), I, 275.

[34] Egon Friedell, *A Cultural History of the Modern Age* (New York: Knopf, 1930), I, 76.

[35] On Neoplatonism, Dionysius the Areopagite and the "magic-mystery," see H. O. Taylor, *The Classical Heritage of the Middle Ages* (3rd ed., New York: Macmillan, 1929), pp. 82–106.

[36] H. O. Taylor, *The Mediaeval Mind,* II, 486–492.

[37] See J. W. Draper, *History of the Intellectual Development of Europe* (rev. ed., New York, 1876), I, 404.

[38] E. Brehaut, *op. cit.,* p. 33.

[39] *Ibid.,* pp. 29, 65.

[40] H. O. Taylor, *The Mediaeval Mind,* I, 105.

[41] Lynn Thorndike, *op. cit.,* I, 628.

[42] Isidore, *Etymologies,* xvi, 26, 10. I am citing here Thorndike's abridged translation (*op. cit.,* I, 627–628).

[43] E. Brehaut, *op. cit.,* p. 34.

[44] Cf. Isidore, *Etymologiae,* xiii, 7, 1–2.

[45] Cf. G. G. Fox, *The Mediaeval Sciences in the Works of John Gower* (Princeton: Princeton University Press, 1931), pp. 18–36, for literary applications of the doctrine of the *microcosm.*

[46] See F. H. Garrison, *An Introduction to the History of Medicine* (Phila-

delphia and London, 1914), pp. 61–62; W. Libby, *History of Medicine* (Boston: Houghton Mifflin, 1922), p. 43; D. Riesman, *The Story of Medicine in the Middle Ages* (New York: Hoeber, 1936), pp. 304–307.

[47] E. Brehaut, *op. cit.*, p. 79.

[48] *Ibid.*, p. 67.

[49] *Ibid.*, p. 64.

[50] H. O. Taylor, *The Mediaeval Mind*, II, 532–534.

[51] C. H. Haskins, *Studies in the History of Mediaeval Science* (2nd ed., Cambridge: Harvard University Press, 1927), p. 262; E. Kantorowicz, *Frederick the Second* (London: Constable, 1931), pp. 350–359.

[52] See W. H. Hudson, *The Story of the Renaissance* (New York: Holt, 1924), p. 6, quoting from Lewes, *History of Philosophy*, II, 95–96.

[53] See Eric T. Bell, *The Search for Truth* (Baltimore: Williams and Wilkins, 1934), pp. 132–46, for a diverting, though unsympathetic, satire upon mediaeval thought; H. E. Barnes, *The History of Western Civilization* (New York: Harcourt Brace, 1935), I, especially Chs. X and XX, for a critical estimate, based on the criteria of modern science; Egon Friedell, *op. cit.*, I, Chs. II and III, for a psychological interpretation, emphasizing the rôle of metaphysics in mediaeval thought; J. Huizinga, *The Waning of the Middle Ages* (London: Arnold, 1927), for numerous references to psychopathic social phenomena of the later Middle Ages; Ralph Adams Cram, *The Great Thousand Years* (Boston: Marshall Jones, 1919), and *The Substance of Gothic* (2nd ed., Boston: Marshall Jones, 1925), for enthusiastic approval of the mediaeval spiritual and artistic sense, hailing the coming of the "new Middle Ages"; N. Berdyaev, *The End of Our Time* (London: Sheed and Ward, 1933), pp. 69–120, on the "new Middle Ages." H. O. Taylor, *The Mediaeval Mind*, is still the soundest critical, but sympathetic, analysis of mediaeval thought and emotion.

[54] Ferdinand Lot, *op. cit.*, pp. 190–191.

[55] E. K. Rand, *op. cit.*, pp. 86–87; E. Brehaut, *op. cit.*, pp. 66–68.

[56] E. Brehaut, *op. cit.*, p. 77.

[57] See H. O. Taylor, *The Mediaeval Mind*, II, 95.

II

SHAKESPEARE ON SLEEP AND DREAMS

IN THIS day and age when writers are so obviously concerned with contemporary happenings and with recent discoveries in science and psychology, it is probably quite superfluous to remind ourselves that other writers of other times were similarly absorbed with the background of their period. So often, however, we have a tendency to study great literature as though it were written in a vacuum. We feel that the masterpieces of a genius are spun, as a spider does its web, from material which lies only within himself, instead of being gathered, as the bee does its honey, from the whole world of knowledge. Such a conception, however, has long been recognized as erroneous. Thomas Henry Huxley, for example, in his essay "Science and Culture," says,

> . . . we cannot know all the best thoughts and sayings of the Greeks unless we know what they thought about natural phenomena. We cannot fully appreciate their criticism of life unless we understand the extent to which that criticism was affected by scientific conceptions.

This statement obviously fits any period of literature, but especially does it apply to the age of the English Renaissance whose great writers have been called "the buccaneers of the high seas of literature." "The student's duty," then, "is to get to know the opinions and feelings of the folk amongst whom his author lived." In consideration of the rebirth of learning and the interest in and further development of popular mediaeval science which permeated Elizabethan England, this duty falls doubly upon us who would make the

attempt to interpret the art of Shakespeare. Many years ago Oliver Elton said that the chief critical task of our time is to understand the mind of the English Renaissance, while more recently J. Dover Wilson spoke of

> the whole vast continent, mostly unexplored so far of the Elizabethan mind, the mind of Shakespeare's audience and of Shakespeare himself, with its alchemical and astrological prepossessions, its demonology and its ghost lore, its barbarous medicine and its bizarre psychology. . . .

If in the course of our reading, then, we should happen upon a passage in Shakespeare which does not immediately seem clear to the twentieth century mind, it is not for us to sit in a corner and try to guess its meaning, or even to attempt to reason it out. Our only recourse in such an event, and it becomes well-nigh a duty, is to discover what Shakespeare's audience understood by the passage. For in the last analysis what the audience understood is what Shakespeare meant. The genius of Shakespeare lies in his ability to take the dull metal of mere fact and story and by the alchemy of his mind to transform it into the gold of great literature. All of this is very trite, and it is offered in a truly apologetic spirit, but we are usually so impressed by the beauty and power of Shakespeare as a dramatist, that we forget that he may not have meant what we think he means.

The Elizabethan conceptions of sleep and dreams take on a good deal of interest for us when we recall the large number of poems written on these subjects, not to speak of the numerous times when Shakespeare has made use of figures directly based on these conceptions. Elizabethan writers on the psychology of sleep usually define sleep as a kind of separation of the soul from the body,[1] or a rest of the five outward senses, together with the sixth or common sense.[2] During this time it is the phantasy or fancy alone which is

[1]For footnotes see page 130 of this pamphlet.

free, as we can see by the numerous dreams that people have. As Levin Lemnius, writing in 1581, puts it,

> Sleepe is nothing els but a restinge of the Animal faculty, and a pawsing from the actions and busines of the day, wherby the vertues of the bodies being faynt, and the powers thereof beinge resolued, are reuiued and made fresh againe, and all the weary members & Senses recomforted. For when the powers natural be fresh and lusty, natiue heate gathering it self inward, is of more force and strongly applyeth concoction, perfourming the same not onely in the Stomack, but also through the whole body beside, whose vapour and pleasaunt sent moisteneth the brayne, & bringeth a sleepe the Instrumentes of the Senses.[3]

Albertus Magnus, in his popular commentary on Aristotle's treatise on sleep, simplifies the matter somewhat more. In a normal state of mind and body, according to Albertus, there exist the spirits which are the vehicle of all the processes of life proceeding from the soul. These spirits originate beneath the heart and are created by the action of bodily heat upon the moisture of food. From the heart the spirits flow first to the liver, where they become natural spirits, governing the involuntary processes (especially digestion); and second they flow to the brain where they become the animal spirits, governing the functions of the five senses, thinking, and imagination. Now these spirits being naturally warm and subtle, move outward through the pores and evaporate. When a sufficient amount has evaporated, the external organs become cold, driving the spirits inward, and sleep naturally ensues.[4] Sleep then, as Dr. Wirtzung tells us in the 1598 edition of his *General Practise of Physicke,* is merely a warming and moistening of the spirits, and when this process is entirely completed, we awaken.[5] Some such conception seems to underlie several passages in Shakespeare. It is quite true that there is a strong literary as well as scientific tradition for much of the science which we are discussing, but the point is that for the Elizabethans these passages are not mere figures of speech, but are the repre-

sentation of a definite and conscious understanding of the science which lies back of them. In *Hamlet,* for example, the king of the play within the play says:

> My spirits grow dull, and fain I would beguile
> The tedious day with sleep.[6]

Or again Prospero, in *The Tempest,* says to Ferdinand:

> Thy nerves are in their infancy again
> And have no vigour in them.

"So they are" replies Ferdinand,

> My spirits, as in a dream, are all bound up.[7]

And in the same play, Sebastian, remarking:

> I find not myself disposed to sleep,

receives from Antonio the reply:

> Nor I; my spirits are nimble.[8]

Notice, however, that the genius of Shakespeare did not feel itself called upon to give a physiological explanation of sleep at any point in the plays. George Chapman, on the other hand, constantly displays the wealth of learning which lay at his finger tips, although in doing so he interrupts the progress of his plays and is consequently so much the less a dramatist. In *The Tragedy of Chabot,* for example, Chapman has the Proctor-General say:

> I mean not sleep, which the philosophers call a natural cessation of the common, and, consequently, of all the exterior senses, caused first and immediately by a detention of spirits, which can have no communication, since the way is obstructed by which these spirits should commerce, by vapours ascending from the stomach to the head; by which evaporation the roots of the nerves are filled, through which the (animal) spirits (use) to be poured into the dwellings of the external senses.[9]

Indeed, to have a thorough understanding of this passage from Chapman, it is necessary to go to those Elizabethan psychologists who were somewhat more familiar with current developments of mediaeval science. These writers may be best represented by Thomas Coghan, Andreas Lauren-

tius, and Petrus Valentinus, — all physicians, whose works were published between the years 1584 and 1612. According to them, the causes of sleep must be divided into four logical groups called the material, formal, efficient, and final causes. The material cause, according to Petrus Valentinus' *Epitome of . . . Physicke,* 1612, is the sweet and pleasant vapor or fume which, produced by the digestion in the stomach, rises to the head where (being congealed by the coldness of the brain) it stops up the passages of the senses and spirits so that the members of the body cease all motion.[10] Thomas Coghan in the 1584 edition of his *Haven of Health* says that such a theory can be plainly demonstrated by the fact that we are most prone to sleep immediately after eating, and that the more volatile things, such as wine, most dispose us to sleep.[11] The formal cause is the withdrawal of the five senses from the outward parts to the inward. The efficient cause is the withdrawal of the heat from the outward parts to the inward so that the organs of digestion may better function. This is the reason we need more covering while sleeping than while waking. There are three final causes of sleep: first, that the brain and heart may be moistened and rested; second, that the action of the liver and stomach may be stronger; and third that sleep may be the image or brother of death, for as in sleep the body rests while the soul remains awake, so in death the body rests while the soul and spirit live.[12] This last conception of the likeness of sleep to death is discussed by numerous Elizabethan authors who find the reference in three classical writers, namely, Ovid, Cicero, and Seneca.[13] Shakespeare frequently refers to this conception. Macduff, for example, tells Malcolm to

> Shake off this downy sleep, death's counterfeit,
> And look on death itself![14]

Oberon, in *A Midsummer Night's Dream,* speaks of "death-counterfeiting sleep," while Iachimo, in *Cymbeline,* calls sleep the "ape of death." So it is that Prince Hal can not recognize that the king is sleeping, but thinks him dead.[15]

Sleep, furthermore, as the physicians proved, is very necessary for the health of our bodies. Levin Lemnius, whose *Touchstone of Complexions* was published in 1581, tells us that sleep

> refresheth the wearied powers of the body, fyrreth vp the Spirites, recreateth the mynde, putteth away sorrow, & bringeth a man into good and quiet temper.[16]

John Jones, writing in 1579, says that there is a threefold necessity for sleep: it rests the wasted spirits, quiets the wearied senses, and improves digestion; for if there were no sleep, sense perception would perish, and with it life.[17] While Robert Burton in the *Anatomy of Melancholy* (1621) informs us that sleep

> moistens and fattens the body . . . and helps digestion (as we see in dormice, and those Alpine mice that sleep all winter) . . . when they are so found sleeping under the snow in the dead of winter, as fat as butter. It expels cares, pacifies the mind, refresheth the weary limbs after long work. . . .[18]

Shakespeare makes use of these scientific facts of the healing nature of sleep in that terrible, yet beautiful speech of Macbeth when he has just murdered Duncan:

> Methought I heard a voice cry, "Sleep no more!
> Macbeth does murder sleep,"—the innocent sleep,
> Sleep that knits up the ravell'd sleave of care,
> The death of each day's life, sore labour's bath,
> Balm of hurt minds, great nature's second course,
> Chief nourisher in life's feast,—. . .
> Still it cried, "Sleep no more!" to all the house;
> "Glamis hath murder'd sleep, and therefore Cawdor
> Shall sleep no more; Macbeth shall sleep no more."[19]

In Thomas Dekker's *The Guls Horn-Book,* there appears an interesting digression in which sleep is called

so inestimable a Jewel, that, if a Tyrant would giue his crowne for an houres slumber, it cannot be bought: . . . yea, so greatly indebted are we to this kinseman of death, that we owe . . . halfe of our life to him: and thers good cause why we should do so: for sleepe is that golden chaine that ties health and our bodies together. Who complains of want? . . . of cares? . . . whilest he sleepeth? Beggers in their beds take as much pleasure as Kings: . . .[20]

Shakespeare takes the same idea as that expressed in this straightforward statement of his contemporary, and turns it into a famous passage in *2 Henry IV* when the king, unable to sleep, paces the floor of his bed-chamber:

> How many thousand of my poorest subjects
> Are at this hour asleep! O Sleep, O gentle Sleep,
> Nature's soft nurse, how have I frighted thee,
> That thou no more wilt weigh my eyelids down
> And steep my senses in forgetfulness?
> Why rather, Sleep, liest thou in smoky cribs,
> Upon uneasy pallets stretching thee
> And hush'd with buzzing night-flies to thy slumber,
> Than in the perfum'd chambers of the great,
> Under the canopies of costly state,
> And lull'd with sound of sweetest melody?
> O thou dull god, why li'st thou with the vile
> In loathsome beds, and leav'st the kingly couch
> A watch-case or a common 'larum-bell? . . .
> Canst thou, O partial Sleep, give thy repose
> To the wet sea-boy in an hour so rude,
> And in the calmest and most stillest night,
> With all appliances and means to boot,
> Deny it to a king? Then happy low, lie down!
> Uneasy lies the head that wears a crown.[21]

Elizabethan writers on sleep go beyond philosophical and physiological considerations, however, and give directions for healthful sleep. Levin Lemnius suggests that we should sleep eight hours, Andreas Laurentius and William Vaughan recommend seven hours, while Thomas Elyot in *The Castel of Helth* feels that the amount of sleep needed should be guided by the state of health, the age, and the natural complexion of the individual.[22] Healthy men having good digestion need far less sleep than those with weak stomachs, the

middle-aged need less than the very young or the very old, while sanguine and choleric men need less than phlegmatic ones, and melancholic men need most of all.[23]

As for the time to sleep, there seems to be a great deal of unanimity, all of the writers whom I have encountered advising, as one might expect, that we should sleep at night and should begin our sleep from two to four hours after eating.[24] If for some reason or other you find that you must sleep immediately after a meal, says Andrew Boorde, you should go to sleep standing up against the cupboard, or sitting upright in a chair, otherwise divers infirmities will be engendered such as the dropsy, the gout, and diseases of the spleen.[25] But whatever you do, don't go to sleep in the daytime, cautions Dr. Peter Lowe, for such an action will fill the brains full of humidity, interfere with digestion, and bring on such symptoms as ganting, risting, heaviness of the members, catarrh of the head, and various other sicknesses.[26] Shylock realizes all this, for he intends to get rid of Launcelot, who, he says, "sleeps by day more than the wildcat."[27] The prolific Thomas Dekker, after considering the habits of young women, thinks otherwise, however, for he insists, although without medical authority, that

> midday slumbers are golden; they make the body fat, the skin faire, the flesh plump, delicate and tender; they set a russet colour on the cheekes of young women, and . . . make us thrifty, both in sparing victuals . . . and in preseruing apparell; for while wee warm us in our beds, our clothes are not worn.[28]

When you have decided that it is time to go to bed, rest first on the left side for a little while. But before you go to sleep be sure to turn on your right side so that the meat in the stomach will be near the liver, for, as Elyot, Burton, and others remind us, the liver is to the stomach as the fire is to the pot.[29] Andrew Boorde suggests that if you are troubled with poor digestion, it will be all right for you to sleep

groveling on your stomach.[30] But never sleep on your back, for according to Lemnius you will get apoplexies, palsies, the falling sickness, etc.[31] Laurentius explains that if you sleep on your back the ordinary excrements of the brain, which are usually purged through the nose and mouth, are likely to fall upon your backbone; or again, sleeping on your back will probably increase the heat of the kidneys, engender the stone, and will certainly send great quantities of vapors into the brain.[32]

Both Boorde and Lowe caution you that if you are especially careful of your health you will give attention to your covering too. Your night cap should be scarlet. Your quilt should be made of cotton, flax, or clean wool, and should be covered with white fustian. Be sure that your feet and head are well covered as coldness of the extremities is bad for the health. Neither should you sleep too cold nor too hot, and your bedroom windows must always be closed at night.[33]

For the most restful sleep, Dr. Bullein emphasizes the necessity for a quiet mind. That is the reason, as Rosalind tells Orlando, that "a priest that lacks Latin . . . sleeps easily." The malady of love, of course, interrupts sleep by interfering with this quiet of the mind. Thus Valentine, in *The Two Gentlemen of Verona* says, "Love hath chas'd sleep from my enthralled eyes."[34] Robert Burton urges you to lie in clean linen, and read some pleasant author or listen to sweet music. Shakespeare concurs in this statement when Glendower, in *1 Henry IV*, tells Mortimer to be quiet while his Welsh-speaking wife sings:

> And rest your gentle head upon her lap,
> And she will sing the song that pleaseth you
> And on your eyelids crown the god of sleep,
> Charming your blood with pleasing heaviness.[35]

It is well, continues Burton, to sleep in a dark room and to have some basin of water gently dripping near your bed. It

is a good idea, too, if you will take a stiff drink of ale or muscadine, or any other posset before you go to bed; some even recommend a sup of vinegar. "Inns and such like troublesome places," says Burton,

> are not for sleep; one calls ostler, another tapster, one cries and shouts, another sings, whoops, halloos, ... Who not accustomed to such noises can sleep amongst them?

One other point should be mentioned with regard to healthful hints for sleeping, and this is the matter of having too much or too little sleep. Too much sleep makes the body liable to palsies, apoplexies, rheums, and impostumes. It also dulls the wits and hinders the memory, filling the brain full of gross humors.[36] One of the most interesting discussions I have come across on the general subject of sleep, and especially too much sleep, appears in a collection of essays by Sir William Cornwallis, printed in 1610 at just about the time when Shakespeare retired from London to end his years at Stratford. It is such a good illustration of the Elizabethan essay, and applies so directly to our subject that it may be well to quote this brief essay in its entirety. "My custom," begins Sir William,

> is about this time of day to sleepe, to auoide which now I choose to write so, if this bee a drowsie stile, and sleepily done, yet if it be not worse then sleepe, I goe not backward, for it serues in sleepes roome. This sleepe is to me in the nature that Dung is to Ground, it makes the soile of my apprehension more solid, & tough, it makes it not so light, & pleasant, & I am glad of it, for I find my selfe too much subiect to a verbal quicknes; thus I think it good for me that I am of a drie barraine mould, but for others it may hap to make them waterish; the cause of this is common, as the effect, yet as some bodies are more subiect to it then others, so meats of one kinde prouoke it more then another. This makes me often play the Epicure, making my stomacke a coward, to fight with Partridge, Phesant, and much foule, whose Ayrie parts are more fine, and poyson not the brain with thicke vapours. The foure-footed Beastes are dull and grosse, and so is what proceeds from them. Well, for my part I will put away this sleepy humour, for it is an extreame spender. When I come at the end of a whole weeke to reckon how I haue bestowed it, in that seauen daies I finde nothing, but Item in sleepe, Item in sleepe: And in the end *Summa*

totalis, seuen nights, seuen Afternoones, beside halfe houres, and quarters, at vnaccustomed times; there is no proportion in this, especially to bestow so much of winking, I cannot blame *Alexander* though hee misliked it, and held that, and Lust, the arguments of Mortalitie; If he had vsed eight of clocke-houres, the *Persian* Empire might yet haue stood. Not so much but good Husbands hate it; and *Pedantes* haue made it a maine supporter of their instructions. I would liken it to Death, for it killes Eternitie, Fame neuer knew a perpetuall Bedpresser. Is it not a pittiful thing to see a fellow bestow halfe his Patrimonie in hobby-horses? then pitie all, who hauing but a little time, dedicate that to sleepe. But this is the effect of our Bodies, who in despight of our soules Diuinitie, will follow their naturall Inclinations, to lie along, and be sencelesse like their earthly Originall.[37]

If too much sleep has these bad effects, too little sleep is likewise dangerous for the body. It debilitates the animal spirits, hinders digestion, and makes the body apt to consumptions. Furthermore it causes dryness of the brain, madness, and makes the body dry, lean, and hard.[38] Thus Katherine, in *The Taming of the Shrew,* complains of her treatment, saying:

> But I, who never knew how to entreat, . . .
> Am starv'd for meat, giddy for lack of sleep.[39]

Men of the melancholic humor are especially susceptible to insomnia because of the continual cares, fears, and sorrows with which their dry brains afflict them. That Shakespeare understood this medical dictum we can see in *The Winter's Tale* when Paulina speaks of Leontes' inability to sleep, saying:

> . . . I
> Do come with words as medicinal as true,
> Honest as either, to purge him of that humour
> That presses him from sleep.——[40]

or when the abbess in *The Comedy of Errors* remarks that Antipholus has been driven mad because he lacks sleep.[41]

Elizabethan physicians recommend the use of several concoctions in cases of insomnia. Dr. Wirtzung suggests sirup of citrons, wormwood wine, or lettuce eaten in the evening.

Some urge the use of poppy, violets, roses, nutmegs, mandragora, etc., taken in distilled water, while there is one remedy which uses the fat of a dormouse applied to the soles of the feet.[42] Iago seems to have been acquainted with various sleep-producing drugs, for, in a passage remarkable for its melody, he tells Othello:

> Not poppy, nor mandragora,
> Nor all the drowsy syrups of the world,
> Shall ever medicine thee to that sweet sleep
> Which thou ow'dst yesterday.[43]

It should be of interest to note that Elizabethans recognized the disease encephalitis, which they called *coma somnolentum*. According to Dr. Philip Barrow this sleeping sickness is caused by hot and moist vapors arising from inferior parts and moistening the brain.[44]

No discussion of sleep and the infirmities thereof would be complete without a discussion of the nightmare, sometimes called the *incubus*, or the witch. This is an affliction wherein a man thinks he is stifled with a great weight lying on him in his sleep; it is usually accompanied by difficulties in speech, in breathing, and in motion. It usually occurs during the first sleep of night, when you are lying on your back. The sensation is of something creeping from the feet up the legs to the chest where it vexes you as though it were a ghost.[45] Peter Le Loyer, in his *Treatise*, describes the symptoms as follows:

> A great difficulty of breathing doth always attend and accompany any them which are surprised therewith; and they have their senses wholy as it were confounded and besotted. In their sleepe they have an imagination that they are even strangled or choaked; and that they feel a kinde of maladie sodainly comming and seizing vpon them. And more than so, their voyce for the time is suppressed and taken away, and they can not be vnderstoode plainly or distinctly, but as if they stammered; by reason that to their seeming they imagine some man or woman . . . dooth stop their mouth for feare they should cry. They moove their armes and their legges to and fro in their bedde, thinking so to chase and drive them away, but all in vaine.[46]

In Shakespeare's day there were two views held concerning the nightmare. Some of the priests and most of the folk held that the disease was caused by evil spirits, either *incubi* or *succubi,* who defile the body at night since they are not able to prevail during the day. The physicians and more enlightened people believed it to be merely a disease caused by various indiscretions. Let us examine the first view, the basis of which seems to lie in a passage from the sixth chapter of *Genesis,* relating that the sons of God took wives from the daughters of men, and that there were giants in the earth in those days. Many of the church fathers, such as Tertullian, St. Augustine, and St. Thomas Aquinas, had written at length upon the validity of interpreting the "sons of God" to be evil angels, or evil spirits. Andrew Boorde says that he once talked with a nun of St. Albans who was so troubled, and that she convinced him as well as others. That great book of witchcraft, the *Malleus Maleficarum,* explains that when the evil spirits take on the forms of men, they can not only see and hear, but they can eat and digest food, and engage in various human activities. Furthermore, when the bodies of the evil spirits perform these functions, they do so more delicately than earthly bodies because the eyes and ears of the mind are far more subtle than the bodily senses.[47]

If you are troubled with the nightmare and feel that the cause is indeed an evil spirit sitting on your chest, you may have recourse to several remedies derived from folklore. You may, for example, copy the first five verses of *St. John's Gospel* on the sacramental paten, and then wash off the writing into a dish of water (dipped up by a pure person) in which have been soaked five herbs; add holy wine to the mixture; say three masses over the whole; and you won't have any more nightmares. Or you can find a stone with a

natural hole in it and hang it on your bed. Perhaps on the whole the easiest thing to do is to say a magic charm before you go to bed. The character John in Chaucer's *Miller's Tale* used to repeat the following night-spell:

> Jhesu Crist and seinte Benedight,
> Blesse this hous from every wikked wight,
> For nyghtes verye, the white *pater-noster!*
> Where wentestow, seinte Petres soster?[48]

And many of us probably recall an old spell, said to the four posts of the bed, which runs:

> Matthew, Mark, Luke and John
> Bless the bed I lie upon.

This may be considered as nothing more than a charm against the nightmare and other evil spirits of the night. Reginald Scot, in the *Discovery of Witchcraft* (1584), records an interesting spell which runs as follows:

> S. George, S. George, our ladies knight,
> He walkt by daie, so did he by night;
> Untill such time as he hir found,
> He hir beat and he hir bound,
> Untill hir troth she to him plight,
> She would not come to hir that night.[49]

While Edgar in *King Lear,* feeling that he is troubled with the nightmare, as well as other fiends, repeats the following:

> St. Withold footed thrice the 'old;
> He met the night-mare, and her ninefold;
> Bid her alight,
> And her troth plight,
> And, aroint thee, witch, aroint thee![50]

With such a wealth of magic rites and charms, then, you should never any more have trouble with the nightmare.

But perhaps you agree with the Elizabethan physicians that the nightmare is merely a disease of bodily infirmity caused by an excess of drinking or a continual irritation of the stomach, from which gross and cold vapors ascend to the head, filling the ventricles of the brain. Another cause is that these same raw vapors and melancholic blood proceed

to the regions around the heart and lungs, there creating a feeling of oppression. Some physicians consider the nightmare as a species of apoplexy, or, as they call it, the falling sickness. It differs from apoplexy only in that the vapors of apoplexy are venomous.[51] Falstaff probably has this in mind when he says to the Chief Justice:

> This apoplexy is, as I take it, a kind of lethargy, . . . a kind of sleeping in the blood, a whoreson tingling . . .[52]

If you are susceptible to the nightmare you should be very careful because this disease often leads to others such as the squinzy, convulsions, madness, and the falling sickness. Do not despair, however, for the Elizabethan physicians have many remedies for you. First of all you should avoid sleeping on the back, and should not eat flesh, eggs, veal, hare, venison, beef, or anything which produces a heavy stomach after supper. When you go to bed, put out of your mind any terrible objects or thoughts which may have come to you during the day. If these preventive measures are not efficacious, you might try wearing peony roots tied around the neck. One of the very best prescriptions is the following, which is good to strengthen the heart and the brains so that they can throw off the evil vapors: Take of red coral, mace, saffron, hart's bones, pearls, and burnt silk a dram each; take of galingale, cardamom, grains, long pepper, cloves, nutmegs, cleansed myrtle, peony kernels, and cinnamon an ounce each; mix these together with 34 ounces of white sugar, and boil in bugloss water until it makes an electuary. In the morning and evening you should eat a quantity of this compound the size of a large nut, and follow it with a draught of water in which peony roots have been decocted. If you still can get no relief, your trouble probably is that you are of a melancholic or sanguine complexion.[53]

Elizabethans then, as we have found, gave a good deal of

consideration to the nature of sleep; it would naturally follow that they would also give their attention to the subject of dreams. And so they did. This matter of dreams, too, should be especially fascinating for us because of the fairly recent interest in that abnormal psychology which busies itself with the manifestation of the unconscious in sleep, for it would seem likely that the beginnings of modern dream psychology lie in certain philosophical, medical, and psychological doctrines which many authors of the English Renaissance got from mediaeval writers and further developed.

Dreams, as we recall, are the natural concomitance of the fact that during sleep, when the outward senses are at rest, it is the fancy or phantasy which lies awake to direct our activities. "A dreame," writes Christopher Langton,

> is nothynge, but an ymagination made in the sleape, whan that dyuers spirites meete togyther in the brayne, whyche beyng the instrument of our thoughtes, do make dyuers ymages. Furthermore in sleepe, the inner senses be a great deale more at lybertye than the vtter be.[54]

Or as Thomas Nashe puts it, in *The Terrors of the Night,*

> A dreame is nothing els but a bubling scum or froath of the fancie, which the day hath left vndigested; or an after feast made of the fragments of the idle imaginations.[55]

The matter is not so simple, however, as Nashe would have us believe, because we must consider the problem of the images of dreams. For as Dr. Timothy Bright reminds us, our dreams show us how the soul, although it lacks the use of the organs of sense, nevertheless is able to see, hear, speak, or experience any action whatsoever (together with the emotions accompanying it) as well as if we were actually awake. Furthermore, these pictures are not merely images of outward things which have been presented to our phantasy by common sense or by memory, because if this were so, we should still be able to fancy (or dream), even though

being awake, whereas when we are awake we are thoroughly aware that these images are derived from the phantasy. The fact is, continues Dr. Bright, that the soul is so closely linked to the body, that during our waking hours the body actually hinders the actions of the phantasy. In other words, in sleep our phantasy can perceive those truths which are denied to it when we are awake, and it is the mind alone, not the senses, which is able to experience these things.[56]

Thomas Hobbes, writing some fifty years later, insists that since the organs of sense are benumbed in sleep, and therefore cannot be stimulated, dreams must be more clear, even, than waking sensations; this is the reason it is so difficult to distinguish between reality and dreams. Hobbes adds, however, that he has no such difficulty, for when waking he can often recognize the absurdity of his dreams, but in his dreams, he never recognizes the absurdity of his waking life. Others are so troubled, though. In *A Midsummer Night's Dream,* for example, Demetrius says to Helena:

> Are you sure that we're awake? It seems to me
> That yet we sleep, we dream.[57]

And Hobbes goes on to use the fact of this difficulty to explain the tales some people tell that they have seen ghosts, fairies, goblins, or think they have seen the power of witches. Hobbes here adds the gratuitous information that although he does not believe in witches, yet they ought to be punished anyway since they think their witchcraft is a real power and would do harm if they could.[58]

There are many causes of dreams. According to Batman, dreams come from a vaporous humor rising from the stomach to the brain in natural digestion, or from too much food, or drink, or from sleeping on the back.[59] Thus in a play by Beaumont and Fletcher, a gentleman asks a scholar,

> Have you no fearful dreams?

and receives the reply,

> Sometimes, as all have
> That go to bed with raw and windy stomachs.[60]

While Imogene, in *Cymbeline*, says of her dream,

> 'Twas but a bolt of nothing, shot at nothing,
> Which the brain makes of fumes. . . . .[61]

Dr. Boorde suggests that dreams may arise from a weakness or emptiness of the head.[62] If we prefer not to dream, another author, writing in 1641, warns us to avoid beans, peas, onions, chestnuts, pork, beef, etc.[63]

But perhaps the best way to get at the cause of dreams is to examine the various kinds according to Elizabethan writers. Dr. Langton refers us to Homer who, in the *Odyssey,* speaks of two kinds of dreams: true dreams which come to us through the gate of polished horn, and false ones which enter through the gate of ivory.[64] Although I have been unable to find references to this idea in Shakespeare, other Elizabethan writers mention it quite often. Spenser makes use of the conception in the first book of the *Faerie Queene,* and Thomas Kyd, in the *Spanish Tragedy,* has the ghost of Andrea say to Revenge:

> Forthwith, Revenge, she rounded thee in th'eare,
> And bad thee lead me through the gates of Horn,
> Where dreames haue passage in the silent night.[65]

Other, and more professional writers, however, make more reasonable divisions. Five kinds of dreams are usually discussed: natural, accidental, divine, diabolical, and supernatural. But some writers combine natural and accidental, while others combine divine, diabolical, and supernatural. Natural dreams are those which are due to the predominant complexion or humor of the individual. The choleric man dreams of wars, fire, or debates; the phlegmatic man dreams of waters, drownings, and storms; the sanguine man dreams of love and happy things; the melancholic man dreams of

death, dangers, and fears.[66] It is very necessary for the physician to be familiar with these facts so that he may be able to know the complexion and constitution of his sick patient, for no man can minister to physical ills unless he knows the dominant humor of his patient.

Another kind of natural dreams, called accidental, occurs when we dream at night on those subjects which fill our minds during the day. Judges dream of controversies of law, soldiers of battles, carters of their carts. If we have talked or thought on anything very earnestly during the day, that will appear in our dreams. And thus a vicious soul will picture to itself in dreams "the terrors that it feareth. . . ."[67] Or as Thomas Cooper explains the matter in his work on witchcraft, 1617,

> And so also by these Dreames may we coniecture of *the sinnes of the heart*: because what we conceiue or practise in the day, will be corruptly dreamed of in the night, to make vs more inexcusable.[68]

Divine dreams are obviously those which God works in men's minds either by himself or else by means of angels, and which give an insight of things to come. David Person postulates a *spiritus universitatis* or universal spirit by which God works in us. Such were the prophecies of Jacob, Joseph, Daniel, and others. And Thomas Churchyard has such a conception in mind when, in his volume of verse called *Chippes,* he writes:

> Yet of som dreams that aer deuien
> Let me a lytell heer defien
> For priuy warnings god doth giue
> By sleeps to thoes that heer do liue.
> Was not the dreams of kings sought owt
> By danniell who, maed cleer eatch dowt . . . .
> By dreams sometims does he [God] procuer
> A man to think on things to com,
> A dream may speak that seemeth dom.[69]

Some writers even think that these angels of God, or souls of dead people may appear actually to a sleeping man; but

the anonymous author of the *Divine Dreamer* insists that this cannot be.[70] Shakespeare's character Antigonus agrees, when in *The Winter's Tale* he relates to the child in his arms:

> I have heard, but not believ'd, the spirits o' the dead
> May walk again. If such things be, thy mother
> Appear'd to me last night, for ne'er was dream
> So like a waking.[71]

Diabolical dreams are, contrariwise, those which are framed in the brain by Satan; they appear especially to witches and conjurers, although they may annoy anyone. Sometimes, states Langton, the devil himself, disguised as an angel, may come to men in their sleep and show them horrible spectacles. Cooper believes you can easily tell the difference between divine and diabolical dreams because the former

> concerne Generall and Necessarie things to bee knowne, as the comming of *Christ, Reuealing* of *Antichrist,* &c. but those from Sathan, are either of curious, or triuiall and vaine matters, eyther not fit, or worthie to be knowne.[72]

Supernatural dreams foreshadow things to come. Langton and Vaughan insist they are not produced by means of any divine power. It is just as reasonable, argues Langton, to find certain men who are gifted by nature in interpreting dreams, as to find others who are gifted in music, medicine, or law. There is no evident cause of this kind of dreams, even in humors or complexions. Vaughan places supernatural dreams midway between natural and divine ones, and states that they are more likely to occur in the early morning when the brain is free from the vapors of the meat, which before had dulled it.[73] Cooper and Laurentius, on the other hand, say that supernatural dreams come either from God or from the devil, and are therefore true or false according to their origin.[74] Several characters in the plays of

Shakespeare have supernatural dreams. In *The Winter's Tale,* Antigonus recalls that he had formerly considered a belief in dreams as superstitious, but he would pay heed to this one:

> Dreams are toys;
> Yet for this once, yea, superstitiously,
> I will be squar'd by this.[75]

Nor must we overlook the passage where Caesar remembers Calpurnia's dream that he will be murdered.[76]

Let us now examine more closely the dreams which are called natural, remembering that these are of two kinds: those which arise from the complexion or temperament of the individual, and those which come from the passions and desires of the mind, inhibited or otherwise. First let us recall that there are four humors arising in the liver which are found in the blood of all men: choler, blood, phlegm, and melancholy. Each man, however, has one of these humors dominant, and thus are produced four types or complexions of men: choleric, sanguine, phlegmatic, and melancholic, according to the dominant humor in the individual. And from the natural and habitual predominance of a particular humor, we have definite characteristics of body, mind, and soul. Now health is nothing but a proper, although not equal, mixture of these humors, while sickness occurs when this mixture becomes deranged. Furthermore, a physician must know the dominant humor in a man before he can prescribe, for each complexion has affinities for certain diseases. Thus, Dr. Lowe gets from Cardan the information that a physician must give attention to dreams so that he may know the type of man with whom he has to deal.[77] Thomas Tryon says:

> Physitians generally agree, that the natural temperament or complexion, and consequently many times the secret Diseases of persons are as soon, or better found out by their *Dreams,* than by any outward signs.[78]

Or as Dr. Wright puts it:

> And in effect we prooue in dreames, and Physitians prognosticate by them, what humour aboundeth, for Choler causeth fighting, blood and wounds; Melancholy, disgrace, feares, affrightments, ill successe, and such like; these dreames are caused by the spirits, which ascend into the imagination, the which being purer or grosser, hotter or colder, more or lesse, (which diuersitie dependeth vpon the humours of the bodie) mooue diuers Passions according to their Nature.[79]

The cause of dreams in melancholy people seems to be a dry brain; thus, when the messenger in the *Faerie Queene* finds Morpheus asleep and shakes him,

> As one then in a dreame, whose dryer braine
> Is tost with troubled sights and fancies weake,
> He mumbled soft, but would not all his silence breake.[80]

We remember too that melancholy men dream of sad and unpleasant things; so Leonato, in *Much Ado,* discusses Beatrice, saying:

> There's little of the melancholy element in her. . . . She is never sad but when she sleeps, and not ever sad then; for I have heard my daughter say, she hath often dreamed of unhappiness and wak'd herself with laughing.[81]

Indeed, Nashe, in *The Terrors of the Night,* tells us that "melancholy is the mother of dreames, and of all terrours of the night whatsoeuer."[82] We recall, further, that choleric men dream of wars, battles, etc. This fact explains a passage in Cyril Tourneur's *Atheist's Tragedy* which reads:

> These idle dreams
> Are fabulous, Our boyling fantasies
> Like troubled waters falsify the shapes
> Of thinges retained in them, and make 'em seem
> Confounded when they are distinguished. So
> My actions daily conversant with war,
> The argument of blood and death have left
> Perhaps the imaginary presence of
> Some bloody accident upon my mind. . . .[83]

Likewise Anne, in *Richard III,* recognizes the choleric temperament when she tells Gloucester:

> Thou wast provoked by thy bloody mind,
> That never dreamt on aught but butcheries.[84]

To continue our discussion of natural dreams, we find that perhaps one of the most interesting conceptions of the Elizabethans has to do with dreams as signs of the secret passions of the mind. In *The Atheist's Tragedy,* Cyril Tourneur has one of his characters explain:

> Dreams are but the raised
> Impressions of premeditated things
> By serious apprehension left upon
> Our minds;[85]

Thomas Nashe, too, relates concerning dreams:

> Diuers haue written diuersly of their causes, but the best reason among them all that I could euer picke out, was this, that as an arrow which is shot out of a bow, is sent forth manie times with such force, that it flyeth farre beyond the marke wherat it was aymed; so our thoughts intensiuely fixt all the day time vpon a marke wee are to hit, are now and then ouerdrawne with such force, that they flye beyonde the marke of the day into the confines of the night. . . . In the daye time wee torment our thoughts and imaginations with sundry cares and deuices; all the night time they quake and tremble . . . , and still continue thinking of the perplexities they haue endured. . . . Our cogitations runne on heapes like men to part a fray, where euerie one strikes his next fellow. From one place to another without consultation they leap, like rebells bent on a head, Souldiers just vp and downe they imitate at the sacke of a Citie, which spare neither age nor beautie; the yong, the old, trees, steeples, & mountaines, they confound in one gallimafrie.[86]

That such conceptions of dreams are eminently correct is shown by many scientific writers of the sixteenth and seventeenth centuries. Lemnius, for example, tells us that dreams come either from the business and actions of the day which impress themselves upon our memory, or else from some earnest or greedy desire which we should like to bring to pass:

> For what things soeuer, a man earnestly and exceedingly desyreth, or hath his minde still running on, the same (being a Sleepe) hee thinketh and dreameth vpon in the night.[87]

"Likewise," concurs the anonymous author of the *Divine Dreamer,*

> such men as have sustained some great losse, either in their honours,

body, goods, parents, kindred or friends, and oftentimes in their dreames they haue very strange, fearfull and mournfull apparitions: . . . .[88]

And so it is, writes John Melton, that your lawyer dreams of money,

A most blessed dreame, and if he chance to talk in his sleepe, it is most commonly of Demurs, Habeas Corpusses, Sissararas, Writs . . . . The Phisitian he dreams of a great Plague, and if he talks, it is of nothing but Purgations, Vomits, Glisters, and Pills. I knew a Player dreamt that his braines were beaten out with the Corke of a groate bottle of Ale, and as he was speaking the Prologue it hist at him, because he spake so scuruily.[89]

Similarly, Mercutio tells Romeo about Queen Mab, saying:

> And in this state she gallops night by night
> Through lovers' brains, and then they dream of love;
> On courtiers' knees, that dream on curtsies straight,
> O'er lawyers' fingers, who straight dream on fees,
> O'er ladies' lips, who straight on kisses dream, ...
> Sometime she gallops o'er a courtier's nose,
> And then dreams he of smelling out a suit;
> And sometime comes she with a tithe-pig's tail
> Tickling a parson's nose as 'a lies asleep,
> Then dreams he of another benefice.
> Sometime she driveth o'er a soldier's neck,
> And then dreams he of cutting foreign throats,
> Of breaches, ambuscadoes, Spanish blades,
> Of healths five fathom deep; and then anon
> Drums in his ear, at which he starts and wakes,
> And being thus frighted swears a prayer or two
> And sleeps again.[90]

While Samuel Daniel, in his sonnet sequence, *To Delia,* writes,

> Cease, dreams, th' images of day-desires,
> To model forth the passions of the morrow;
> Never let the rising sun approve you liars,
> To add more grief to aggravate my sorrow.[91]

In a consideration of the causes of dreams, however, even more striking are the words of Thomas Tryon, writing near the end of the seventeenth century, which show the importance of dreams in psychological diagnosis:

Since the *Heart of man is deceitful above all things,* therefore for him that would truly *know himself,* it has by the wise Doctors of *Morality*

been always advised to take notice . . . of his usual *Dreams,* there being scarce any thing that more discovers the secret bent of our minds and inclinations to Vertue or Vice, or this or that particular Evil, ... then these nocturnal sallies and reaches of the *Soul,* which are more free & undisguis'd, & with less reserve than such as are manifested when we are awake.[92]

It is fairly obvious, then, that people for many centuries have been curious about the conduct of the body during sleep, and that the Elizabethans were just as assiduous as the most modern of us in inventing answers to their self-put questions concerning dreams. It may be that their psychological probings, as here revealed, will help to guide us to a clearer understanding of the mental processes of the Elizabethans, and hence to a more complete conception of the plays of Shakespeare. Nor must we take a supercilious view of the mental foibles of a past age, for future generations will laugh at us too, for our attempts to fathom the workings of the mind; perhaps some of us are smiling even now.

CARROLL CAMDEN, JR.

NOTES

[1]Timothy Bright, *A Treatise of Melancholy* (London, 1586), 114.

[2]Robert Burton, *The Anatomy of Melancholy* (New York, 1924), 102 (first edition in 1621).

[3]Levin Lemnius, *The Touchstone of Complexions* (London, 1581), 56^{v}–57^{r}.

[4]George G. Fox, *The Mediaeval Sciences in the Works of John Gower* (Princeton, 1931), 95–96; Peter Lowe, *A Discourse of the Whole Art of Chyrurgerie* (London, 1634), 52; Stephen Batman, *Batman vppon Bartholome* (London, 1582), 81^{v}–82^{v}.

[5]Christopher Wirtzung, *Praxis Medicinae vniuersalis; Or A generall Practise of Physicke* (London, 1598), 618.

[6]III. ii. 236–237.

[7]I. ii. 484–486.

[8]II. i. 201–202.

[9]III. ii. 38–50.

[10]Petrus Valentinus, *Enchiridion Medicum: containing An Epitome of the whole Course of Physicke* (London, 1612), 17–18.

[11]Thomas Coghan, *The Haven of Health* (London, 1584), 237.

[12]Andreas Laurentius, *A Discourse of the Preservation of the Sight: of Melancholike diseases* (London, 1599), 94–95; Christopher Langton, *An introduction into phisycke* (London, 1550?), 80^{r}–82^{v}; Lowe, *op. cit.,* 52; David Person, *Varieties* (London, 1635), 246–247; John Jones, *The Arte & Science of preseruing Bodie and Soule in al Health, . . .* (London, 1579), 47–48.

[13] Wirtzung, *op. cit.*, 618; William Bullein, *A newe Boke of Phisicke called ye Gouernment of Health, . . .* (London, 1559), 89.

[14] *Macbeth*, II. iii. 81.

[15] *A Midsummer-Night's Dream*, III. ii. 364; *Cymbeline*, II. ii. 31; *2 Henry IV*, IV. v. 31–37; *Winter's Tale*, V. iii. 18; Chapman, *Tragedy of Caesar and Pompey*, V. v. 105–123; John Davies, *Microcosmosus*, Oxford, 1603, 71; Chaucer calls sleep the "norice of digestioun" (*Cant. Tales*, F., 347).

[16] Lemnius, *op. cit.*, 57r.

[17] Jones, *op. cit.*, 47.

[18] Burton, *op. cit.*, 356–358.

[19] *Macbeth*, II. ii. 35–43. Also cf. *Julius Caesar*, II. i. 231–233; *Macbeth*, III. iv. 141–144; *A Midsummer-Night's Dream*, III. ii. 435; Davies, *op. cit.*, 71–72; Philip Sidney, *Astrophel and Stella*, sonnet 19; Bartholomew Griffin, "Care-Charmer Sleep," *Fidessa;* William Drummond, "Sleep, Silence' Child," Hebel and Hudson, *Poetry of the English Renaissance* (New York, 1930), 565; John Fletcher, "Care-charming Sleep," Hebel and Hudson, 396.

[20] Thomas Dekker, *Non-Dramatic Works*, Huth Library, vol. II, 216.

[21] III. i. 4–31.

[22] Lemnius, *op. cit.*, 57v; Laurentius, *op. cit.*, 189; William Vaughan, *Directions for Health* (London, 1617), 283; Lowe, *op. cit.*, 53; Thomas Elyot, *The Castel of Helth* (London, 1541), 45r–45v.

[23] Burton, *op. cit.*, 356–358; Andrew Boorde (*Dyetary of Helth*, EETS, Ex. Ser., vol. X, 245) says that sanguine men should sleep seven hours, phlegmatic men nine hours, melancholic men as long as they like.

[24] Elyot, *op. cit.*, 45v; Burton, *op. cit.*, 163; Laurentius, *op. cit.*, 189; Bullein, *op. cit.*, 89.

[25] Boorde, *op. cit.*, 245–246.

[26] Lowe, *op. cit.*, 53.

[27] *Merchant of Venice*, II. v. 47–48.

[28] Dekker, *Guls Horn-Book, Non-Dramatic Works*, Huth Library, vol. II, 218.

[29] Elyot, *op. cit.*, 46r; Burton, *op. cit.*, 356–358; Bullein, *op. cit.*, 89–90; Vaughan, *op. cit.*, 284.

[30] Boorde, *op. cit.*, 246–247.

[31] Lemnius, *op. cit.*, 59r–59v.

[32] Laurentius, *op. cit.*, 189–190.

[33] Boorde, *op. cit.*, 247; Lowe, *op. cit.*, 53.

[34] Bullein, *op. cit.*, 89; *As You Like It*, III. ii. 336–337; *Two Gentlemen of Verona*, II. iv. 133; *Richard II*, I. ii. 122; *A Midsummer-Night's Dream*, II. ii. 78–81; Sir William Davenant, "Night's First Song," *Luminalia.*

[35] Burton, *op. cit.*, 356–358; cf. *A Midsummer-Night's Dream*, IV. i. 87.

[36] Vaughan, *op. cit.*, 283; Bullein, *op. cit.*, 90; Gulielmus Gratarolus, *A Direction for the Health of Magistrates and Students* (London, 1574), S3r; Juan Ludovico Vives, *An Introduction to Wysedome* (London, 1550), D4r; Burton, *op. cit.*, 163; Elyot, *op. cit.*, 45v–46r; Lowe, *op. cit.*, 53.

[37] Sir William Cornwallis, *Essayes* (London, 1610), I8r–K1r.

[38] Elyot, *op. cit.*, 46r; Burton, *op. cit.*, 163; cf. Dekker, *op. cit.*, II, 217.

[39] IV. iii. 7–9.

[40] II. iii. 36.

[41] *Comedy of Errors*, V. i. 68; Langton, *op. cit.*, 83r; Davies, *op. cit.*, 72; Burton, *op. cit.*, 456; Laurentius, *op. cit.*, 94.

[42] Wirtzung, *op. cit.*, 651; Lowe, *op. cit.*, 52–53; Burton, *op. cit.*, 457; John Arderne, *Treatises of Fistula in Ano*, EETS, O.S., vol. 139, 100–101; John Banister, *An Antidotarie Chyrurgicall* (London, 1589), 119; Gervase Markham, *The English House-wife* (London, 1631), 12; John Vigo, *The most excellent worckes of Chirurgery* (London, 1550), 229[r]; John Vigo, *Practyce . . . in Medycyne* (London, 1550?), B5[r]; Vaughan, *op. cit.*, 284.

[43] III. iii. 330–333.

[44] Philip Barrow, *The Method of Phisick* (London, 1596), 30–31.

[45] Walter Bruel, *Praxis Medicinae or The Physicians Practice* (London, 1632), 50–51; Wirtzung, *op. cit.*, 182; Bright, *op. cit.*, 128; Barrow, *op. cit.*, 43.

[46] Pierre Le Loyer, *A Treatise of Specters* (London, 1605), 101[v].

[47] Reginald Scot, *Discoverie of Witchcraft*, ed. Summers (London?, 1930, first edition in 1584), 42, 49–50; Andrew Boorde, *Breuiary of Helthe* (London, 1547), 52; John Melton, *Astrologaster, or The Figvre-Caster* (London, 1620) 66–67; Batman, *op. cit.*, 84[r]; Le Loyer, *op cit.*, 101[v]; Thomas Nashe, "Terrors of the Night," *Works*, vol. I (London, 1910), 359; G. L. Kittredge, *Witchcraft in Old and New England* (Cambridge, 1929), 218, 219, 221; cf. Beaumont and Fletcher, *Wit Without Money*, V. i, *Works* (Cambridge, 1905), vol. II, 196.

[48] *Canterbury Tales*, A. 3483–6.

[49] Kittredge, *op. cit.*, 147, 218–219; Scot, *op. cit.*, 49.

[50] III. iv. 125–129.

[51] Barrow, *op. cit.*, 43–44; Bruel, *op. cit.*, 50–51; Bright, *op. cit.*, 128; Melton, *op. cit.*, 66; Batman, *op. cit.*, 84[r]; Boorde, *op. cit.* (1547), 53[r]; Le Loyer, *op. cit.*, 101[v]; Langton, *op. cit.*, 87[v]; Scot, *op. cit.*, 49; Adrian Junius, *The Nomenclator, or Remembrancer* (London, 1585), 427[a]; Lemnius, *op. cit.*, 113[r].

[52] *2 Henry IV*, I. ii. 126–128.

[53] Wirtzung, *op. cit.*, 182–183.

[54] Langton, *op. cit.*, 87[r].

[55] Thomas Nashe, *Terrors*, *op. cit.*, 355.

[56] Bright, *op. cit.*, 114–116; cf. Batman, *op. cit.*, 83[r]; *The Divine Dreamer* (London, 1641), B1[v]; Vaughan, *op. cit.*, 288; Le Loyer, *op. cit.*, 2[r]; Sir John Davies, *Nosce Teipsum* (London, 1599), 47; Fox, *op. cit.*, 96–97; Lemnius, *op. cit.*, 52[r]; Ben Jonson, *The Poetaster*, IV. ix. 29–44.

[57] IV. i. 197–198; cf. *Romeo and Juliet*, II. ii. 139–141.

[58] Thomas Hobbes, *Leviathan* (Cambridge, 1904), 5–7.

[59] Batman, *op. cit.*, 85[r]; cf. Melton, *op. cit.*, 66; Lemnius, *op. cit.*, 52[r].

[60] *The Pilgrim*, III. vi.

[61] IV. ii. 300–301.

[62] Boorde, *op. cit.*, 95.

[63] *Divine Dreamer*, *op. cit.*, B1[v].

[64] Langton, *op. cit.*, 86[v]–87[r]; *Odyssey* (Cambridge, 1921), 398.

[65] Spenser, *Faerie Queene*, I. i. 42, 43, 44; Marlowe, *Jew of Malta*, II. 674–677; Chapman, *Masque of the Middle Temple*, 366–367.

[66] Person, *op. cit.*, 251–252; Laurentius, *op. cit.*, 99.

[67] Person, *op. cit.*, 252; Langton, *op. cit.*, 87[r]–87[v]; Laurentius, *op. cit.*, 99–100.

[68] Thomas Cooper, *The Mystery of Witch-Craft* (London, 1617), 146.

[69] Person, *op. cit.*, 252–253; Langton, *op. cit.*, 88[v]; Thomas Churchyard, *The Firste parte of Churchyardes Chippes* (London, 1575), 73[v]; John Marbeck, *A Booke of Notes* (London, 1581), 316–317.

[70] *Divine Dreamer,* op. cit., B1v.

[71] III. iii. 16–19.

[72] Langton, *op. cit.,* 88r; Cooper, *op. cit.,* 146–148; Batman, *op. cit.,* 83r–84v; Person, *op. cit.,* 253.

[73] Langton, *op. cit.,* 88r–88v; Vaughan, *op. cit.,* 288–289.

[74] Cooper, *op. cit.,* 144; Laurentius, *op. cit.,* 100.

[75] III. iii. 39–41.

[76] *Julius Caesar,* II. ii. 2–3.

[77] Lowe, *op. cit.,* 54.

[78] Thomas Tryon, *Pythagoras His Mystick Philosophy Reviv'd; or the Mystery of Dreams Vnfolded* (London, 1691), 5–6; Lemnius, *op. cit.,* 112v–113r; Laurentius, *op. cit.,* 95.

[79] Thomas Wright, *The Passions of the Mind in Generall* (London, 1621), 65; cf. Batman, *op. cit.,* 83v; Scot, *op. cit.,* 103; Melton, *op. cit.,* 66; W. C. Curry, *Chaucer and the Mediaeval Sciences* (New York, 1926), 205–206; *Divine Dreamer, op. cit.,* B2r–B2v.

[80] I. i. 42.

[81] II. i. 357–362.

[82] Thomas Nashe, *Terrors, op. cit.,* 357.

[83] *Atheist's Tragedy,* III. vi; cf. Chapman, *Revenge of Bussy,* V. i. 36–53; *Richard* III, IV. i. 83–85; Churchyard, *op. cit.,* 73r; Thomas Nashe, "The Praise of Red Herring," *Works,* vol. III (London, 1910), 197–198.

[84] I. ii. 99–100.

[85] III. vi.

[86] Thomas Nashe, *Terrors, op. cit.,* 355–358.

[87] Lemnius, *op. cit.,* 113v–114r.

[88] *Divine Dreamer, op. cit.,* B1r–B1v.

[89] Melton, *op. cit.,* 66–67; cf. notation printed in the margin of *Foure Seuerall Treatises of M. Tullius Cicero* (London, 1577), Q3v.

[90] *Romeo and Juliet,* I. iv. 70–88.

[91] Samuel Daniel, "To Delia," Hebel and Hudson, *Poetry of the English Renaissance* (New York, 1930), 246. Cf. Michael Drayton, "Idea's Mirror," Hebel and Hudson, *op. cit.,* 284; *Cymbeline,* V. iv. 123–151; *Macbeth,* II. i. 20–21; *Othello,* III. iii. 416–418; *Hamlet,* II. ii. 260–268; *Twelfth Night,* II. iii. 187–192; *A Midsummer-Night's Dream,* IV. i. 70–72; *Richard III,* I. iv. 2–74, V. iii. 159–161; Chaucer, *Parliament of Foules,* 99–105. In connection with the passage from the *Parliament of Foules,* editors Walter W. Skeat and F. N. Robinson refer the reader also to Claudian, *De VI Consulatu Honorii Augusti, Praefatio,* ll. 3–10; Vincent of Beauvais, lib. xxvi, c. 62–63; *Roman de la Rose,* opening lines, and ll. 18564, 18601; Macrobius, *Comment. in Somn. Scipionis,* i. 3, 4; Petronius, Fragm. xxx; Boccaccio, *De Genelogia Deorum,* i. 31.

[92] Tryon, *op. cit.,* 6–7. Cf. Batman, *op. cit.,* 84r; Sir Thomas Overbury, "A faire and happy Milk-mayd," *Miscellaneous Works, ed. Rimbault* (London, 1856), 118–119; Thomas Kyd, *Cornelia,* III. i. 61–147; Thomas Traherne, "Dreams," *Poems of Felicity,* Hebel and Hudson, *op. cit.,* 815; *Richard III,* V. iii. 151; *A Midsummer-Night's Dream,* I. i. 152–154; *Comedy of Errors,* II. ii. 184–185.

III

CONTRIBUTIONS OF LOPE DE VEGA TO THE GOLDEN AGE OF SPANISH DRAMA

ONE of the "talking points" of people who try to interest students in modern foreign languages, is the so-called "general culture" value. They say that people can gain no adequate idea of works of literature unless these works are read in the language in which they were written. This argument is countered immediately by the advocates of the study of the "useful" subjects by the recommendation that if you just must read those old-fashioned, uninteresting, dry-as-dust books, written by men who lived long before our enlightened age, why don't you read them in English translation? In preparing this paper on the Contributions of Lope de Vega to the Spanish Drama of the Golden Age, I have been struck, as never before, by the thought: What chance would a person have of gaining a reasonable idea of the works of Lope, who after all, is the outstanding figure in Spanish dramatic literature, by reading him in English translation?

Now Lope was an amazingly prolific and energetic writer. According to his first biographer, he wrote eighteen hundred dramas and four hundred shorter religious plays called *autos sacramentales*. Twenty-two hundred plays! Is it any wonder that Cervantes called Lope a "Monster of Nature" or that he was commonly called by his contemporaries the "Phoenix of Geniuses"? Many of his plays have undoubtedly been lost,

yet there are 426 extant, not counting *autos*. Of this still large number, but *five* have been translated into English at various times between 1805 and 1918.[1] Of these five, only one, "The Star of Seville," is readily available. It is included in Brander Matthews' collection entitled *The Chief European Dramatists*.[2] His non-dramatic works approximately equal in amount that of the plays. He also wrote novels of various sorts, long epics, verse epistles, ballads, and ream upon ream of lyric verse—an almost incredible output, of which hardly an infinitesimal part is available in English translation. But let us really examine Lope's work and see whether he is worth reading at all.

The Golden Age of Spanish literature was the period of approximately a century between 1550 and 1650, that is, from the appearance of the first great picaresque or rogue novel, the Lazarillo de Tormes, in 1554, to the retirement of Calderón from active writing in 1650. Calderón lived on until 1681, but in 1650 he took priestly orders and, unlike Lope, took his duties seriously, thereafter writing only religious *autos*. After Calderón there was a sudden and definite decline in Spanish letters paralleling the decline in political power due to disastrous foreign wars, bad management of affairs at home, and an economic situation which grew ever worse and worse. So that for some 150 years little of worth was produced. But during the Golden Age, Spain was at her zenith, a first-rate power with a brilliant Court life, wealthy, at least apparently, and with a large number of famous authors whose influence was felt abroad as well as at home.

The picaresque novel was the principal prose genre of the time, episodic in form, realistic in its portrayal of the life of the lower classes, sometimes obscene, always bitterly satir-

[1]For footnotes see page 157 of this pamphlet.

ical. As for idealistic fiction, the romances of chivalry which Cervantes so cleverly burlesqued in the *Don Quixote,* were already in decline. The pastoral romance enjoyed a considerable vogue, both Lope and Cervantes writing one each. In poetry, the ballad reached the height of its popularity about 1580.[3] The mystic poets too, including Santa Teresa de Jesús, Luís de León, who has been called Spain's greatest lyric poet, and San Juan de la Cruz, wrote their best works during the last half of the sixteenth century. Let me cite just one example of this Christian poetry, an anonymous sonnet admirably translated into English by Thomas Walsh entitled:

TO CHRIST CRUCIFIED.[4]

I am not moved to love Thee, O my Lord,
By any longing for Thy Promised Land;
Nor by the fear of Hell am I unmanned
To cease from my transgressing deed or word.
'Tis Thou Thyself dost move me, Thy blood poured
Upon the cross from nailèd foot and hand;
And all the wounds that did Thy body brand;
And all Thy shame and bitter death's award.
Yea, to Thy heart am I so deeply stirred
That I would love Thee were no heaven on high,—
That I would fear, were hell a tale absurd!
Such my desire, all questioning grows vain;
Though hope deny me hope I still would sigh,
And as my love is now, it should remain.

Cervantes deserves a place apart from schools and movements. He needs no introduction to you. Let me merely remind you that the "world's greatest novel," *Don Quixote,* was published in two parts, in 1605 and 1615, and the *Exemplary Novels,* which would have established his fame as an author even had he not written *Don Quixote,* in 1613, at the very time when Lope had gained the position of master of the Spanish stage. It was always Cervantes' ambition to be a dramatist, but he failed to please the public. It is unfor-

tunate for the drama that the one man who had the greatest powers of observation and the ability to analyze character should have been unsuccessful in the career which he chose. Perhaps if he had been a better poet and had been able to catch the popular fancy or had been able to mould the public taste according to his own conception of what the drama should be, the whole history of Golden Age drama might have been changed.

During the first years of the sixteenth century there lived two dramatists of some importance, Juan del Encina and Torres Naharro. Juan del Encina was a musician and priest, attached for a number of years to the papal court in Rome.[5] He wrote several religious plays for Christmas, Good Friday, and Easter celebrations, and one farce. Shepherds and hermits were the characters who appeared. They were written in verse, very simple as to plot, in language a faithful imitation of the speech of the people. These productions were played before select audiences *outside the Church.* Thus the great contribution of Juan del Encina was to secularize the drama and make it popular with the aristocracy. He, as a writer of the farce, the pastoral play, and the religious *auto,* had innumerable imitators during the sixteenth and even in the seventeenth century.

His younger contemporary, Torres Naharro, greatly enlarged the picture of the primitive farce.[6] He brought in not only shepherds and hermits but people of all classes and conditions: soldiers and monks, pimps and prostitutes, valets and butlers of cardinals, washerwomen; and from the higher classes even princesses of León, princes of Hungary, marquesas and high born ladies. He ingeniously complicated the plot, he for the first time devoted himself to the study of customs, and if he did not succeed in the comedy of character, he was at least the founder of the comedy of intrigue.

His conception of the *comedia* is fundamentally classic. In the prologue to his collected works, after citing various definitions, among them that of Cicero (*imitatio vitae, speculum consuetudinis, imago veritatis*), he gives his own in these terms: "The *comedia* is nothing else than the ingenious artifice of notable and, in short, *happy* events, represented by people." He goes on further to say: "As regards the kinds of *comedias,* it seems to me that two are enough for our Castillian language: *comedia a noticia* and *comedia a fantasía. A noticia* is to be understood as things seen and noted in truthful reality . . . *A fantasía,* things fantastic or imagined which have the color of truth though they are not. . ."

The next dramatist of note is Gil Vicente,[7] a Portuguese, who wrote eleven plays in Spanish, sixteen in Portuguese, and seventeen in a combination of Portuguese and Spanish. He is most interesting for the lyrical beauty of his verse and for the variety of comic effects produced by the presentation of contemporary types: the shrew and the timid wife, the sluggard and the perpetual dancer, the old man or old woman in love, the negro trying to speak Portuguese or Spanish, the rustic at Court. His themes were mostly satirical: the criticism of the shrewd but ignorant judge, the Jews, the doctors, above all the monks and priests from the humblest mendicant friar to the Pope. It may seem unbelievable that such bitter satire against the Church should come from the most Catholic kingdom of Portugal, but the first third of the sixteenth century was a time when the relations between Rome and the various kingdoms were more or less strained. Henry VIII definitely cut them, other monarchs threatened to do so unless abuses such as the traffic in Bulls were discontinued. In one of Vicente's allegorical satirical plays, *Heaven's Boat,* the Devil complains that in two previous voyages he has had only one gentleman. Death

promises to oblige him and a Count is forthwith brought, who, the Devil says, had during his life-time been full of pride and vanity, bowing down to vice and luxury, without fear of God, and who will now have his reward. A Duke is brought in by Death in the same way and then a King. The Devil tells the latter merrily that he is to dwell in yonder fires. He had been adored in life, careless of the poor, decreeing unjust wars. An Emperor then comes who had been regarded almost as a god on earth, and who had died of vainglory. It is now the turn of the Church. Death brings in a Bishop, who had earned a place in the Boat of Hell by his pride, although, as the Devil slyly adds, he was loved by his children. Then follow an Archbishop, who is upbraided for his avarice and ambition, a Cardinal, who, far from being grateful to God for having been raised from an humble estate to the purple, had died weeping that he had not been even two days pope, and finally a Pope, who has been licentious, proud, and simoniacal. Each of Death's victims, in turn, go to the Angels in the Boat of Heaven, confess their sins and finally are gathered in and take their places on the celestial thwarts. This happy and comfortable doctrine was worth waiting for.

Gil Vicente's stagecraft consisted in presenting a show as fine as could be devised, a miniature ship, a tower, or other fine spectacle, with elaborate costuming. He could do this, for as playwright for the King of Portugal he had almost unlimited funds at his disposal. His plots have little action and the play ends with music, dance, and song. He does not divide plays into acts or scenes, he does not develop plot or character, but in his mingling of comedy and tragedy and in the quality of his verse he foreshadows the coming Golden Age.

In the second half of the century taste changed: the

Italian *comedia* was becoming more and more known in Spain, often being put on in their original language. Prose triumphed in the theatre. All these divergent tendencies have been well summed up by Menéndez y Pelayo[8] as follows: "It was an age of trials and 'feeling one's way'; many germs did not bear fruit; some literary forms devoured others with singular speed; toward the end of the century a kind of lyrical tragicomedy, half classic, half romantic in which both historical and traditional elements were mixed, made its appearance, thus preparing the way for the definitive form of the Spanish drama such as was to come from the hands of Lope de Vega."

Lope Félix de Vega Carpio was born in 1562. The seventy-three years of his life, until his death in 1635, just three hundred years ago, span nearly all the Golden Age, particularly as regards the theatre, for the Golden Age began when Lope, at about the age of twenty-three, began to write for the stage. The events of Lope's life[9] had best be enumerated hurriedly. It certainly was not a life of strict bourgeois morality. He was twice married, once exiled from the Court for defaming the character of an actress and her father, he served in the expedition of the Spanish Armada against the English, and had many illicit love affairs. Late in life he was ordained priest without this solemn event making a great difference in his private life. In fact, on the eve of his ordination we find him complaining, in a whimsical manner, to his patron, that before being ordained he had to cut off his moustache. His attitude reminds us somewhat of that of Henry of Navarre, who, on accepting the Catholic Faith in order to become King of France, is said to have remarked that "Paris is well worth one Mass." After becoming a priest, we still find him acting as go-between in love adventures of his patrons, writing amorous poetry for them

to use in their conquests. He kept on writing for the stage and in general conducting himself as before. He always loved luxury, and though he received a large income from his works he was always pressed for money. His death was hastened and his last years made bitter by the death of his favorite son, who was drowned in the New World, and by the elopement of his youngest daughter under mysterious circumstances.

Yet, we can surely say that Lope was not a vicious sinner. He seems to have realized his shortcomings and to have tried in vain to overcome temptation, a thing impossible to one of his sensitive nature. At this distance in time we prefer to look at the side of his character shown in some of his religious poetry which shows a depth of feeling seldom expressed so well by either churchman or layman. Let me cite just one example, a sonnet, entitled "Tomorrow," translated by Longfellow as follows:

TOMORROW[10]

Lord, what am I, that with unceasing care
Thou didst seek after me, that Thou did'st wait
Wet with unhealthy dews before my gate
And pass the gloomy nights of winter there?
Oh, strange delusion, that I did not greet
Thy blest approach, and oh, to heaven how lost
If my ingratitude's unkindly frost
Has chilled the bleeding wounds upon Thy feet.
How oft my guardian angel gently cried,
"Soul, from thy casement look, and thou shalt see
How He persists to knock and wait for thee!"
And oh, how often to that Voice of sorrow,
"Tomorrow we will open," I replied,
And when the morrow came I answered still "Tomorrow."

When Lope died, however, he seems to have been in good repute with the Church. He was given a royal burial, the ceremonies lasting nine days. Nine bishops read the mass, one after the other. All the religious congregations at-

tended. On the day of the burial, if we may believe the legend, a woman who knew nothing of what was happening but seeing all Madrid in mourning remarked: "This can be nothing less than the burial of Lope."[11]

How did Lope attain this great popularity? By catering to the public taste. He found the formula which pleased the audience, namely, an intricate plot with lots of action for the rabble and bursts of lofty lyric poetry for the cultured element. In dealing with the Spanish theatre of the Golden Age we are dealing with a truly national theatre, that is, one in which the public influenced writers to such an extent that the theatre as a whole is the expression of the ideas, the ideals, the likes and dislikes of the people considered collectively rather than the artistic production of individual authors. Lope himself explains his attitude toward the public in an address,[12] written in verse, which he delivered before a literary academy in Madrid in 1609, as follows: "When I am about to write a *comedia,* I lock the precepts up with six keys, I take Terence and Plautus out of my study, so that they cannot shout at me, for the truth is accustomed to cry out even in mute books, and I write according to the art that those who sought the applause of the public, invented, because, as the rabble pays, it is just to speak to it foolishly to give it pleasure."[13] And later he remarks that the academy had asked him to write an "Art of Writing Plays in Spain" where "everything that is written is contrary to the rules of Art."[14]

Let us examine, now, the external conditions which influenced Lope so greatly in his policies, the condition of the theatres and the elements found in his audiences.

The old farces had been put on only by wandering troupes. Cervantes tells us that he could remember the time, in his boyhood, when all the equipment of a director was enclosed

in a sack and consisted of the articles necessary for the disguise of a shepherd.[15] He says: "In those days there was no stage machinery, no battles of Moors and Christians, no gentlemen on horseback. There was no figure which came out or appeared to come out of the centre of the earth through a hole in the stage which was composed of four or six boards laid on benches which rose about four palm lengths above the ground. Neither did clouds come down from heaven with angels or with souls. The adornment of the theatre was an old blanket pulled by two cords from one side to the other, which made what they called a vestuary behind which were the musicians singing some old ballad without any guitar." By Lope's time, however, the false beards had been taken off, clouds, thunder and lightning, duels and battles had been invented and there were permanent theatres.

In 1561 the Court was transferred from Toledo to Madrid with a resultant rapid increase in population and riches. By 1582, two permanent theatres had been built,[16] controlled by two religious brotherhoods, charitable organizations whose purpose was to feed and clothe the needy and to maintain a hospital for women with contagious diseases. The brotherhoods usually cleared a profit of some ten dollars[17] a performance after paying all expenses. These two theatres proved to be very popular and the income from them rapidly increased, so the Madrid General Hospital was given a portion of the profits but the brotherhoods retained the concession for selling water, fruit, *aloja* (a drink made of water, honey and, spices), and candy.

The theatre itself was merely an open space between buildings with a stage at one end and a low balcony built facing it, in which women sat, separated from the main part of the theatre by an iron grating. The nobility occupied the

boxes, that is, the windows of the adjoining buildings which they rented by the season. The ground floor, which was literally the ground, had no seats. It was here that the rabble, the "great unwashed" stood, talked, ate, drank, and watched the performance, vociferously expressing their approval or disapproval of what went on on the stage.

The stage was raised slightly from the ground level. There was no appeal to the eye except in the matter of costuming which was often very elaborate. There was no front curtain, only a back drop. To indicate a change of scene the actors simply left by one exit and came back in by another, indicating by the lines the scene of the action. For example in the opening lines of "Struggle on unto Death" the leading character says: "Is that an inn?" and his servant replies: "That is the famous inn of Alcolea." The master then asks: "And is that the famous bridge?"[18] The audience at once knows that the two men are approaching the outskirts of Córdoba where this famous inn is located. Sometimes a change of scene was indicated by lifting the back curtain on which a scene was painted, leaving a different one exposed.

These are the conditions under which the drama was to be developed by Lope and his imitators practically without interference from anyone. Spain never did abide much by literary criticism. In fact during the Golden Age we find no first class dramatic critic.[19] No one could speak with authority or influence. Only the voice of the Church carried any weight. Thus the *auto sacramental* came in for some discussion from churchmen, and as the guardian of public morality the secular drama came in for some criticism, but only in regard to the dances, ideas, and times of performances, not in regard to the artistic side of the construction of plays. Controversy was not very violent until the time of Lope when the drama became a means of popular amuse-

ment and when certain writers tried to catch the public approval by appealing to their baser instincts. The Church, at times, succeeded in more or less controlling certain abuses but the public will was stronger, and moreover, the religious fraternities were deriving a large part of their income from the presentation of *comedias,* so that, though the theatres were closed for short periods, the authors and public in conjunction felt relatively little interference in the development of what the public wanted in the way of entertainment.

Let us return now to Lope's "New Art of Writing Plays" and examine further features of his dramatic technique. Lope says: "Let the author choose his subject, and let him not mind whether it concerns kings."[20] In other words, anything is a proper subject for a play. In fact Lope with his enormous number of plays practically exhausted the possible sources. He wrote about everything, scenes from the Bible, events from the history of Spain both written and legendary, events from Classical literature, contemporary events, and many entirely original subjects. Is it any wonder that he used the same materials for two or three different plays at times and that individual scenes in different plays sometimes have a strange similarity. Self-plagiarism is practically inevitable when a man writes 1,800 plays. I think we may safely say, however, that Lope seldom copied the works of any other dramatist, though this was not considered unethical in his day. He simply found it easier to devise a plot from his fertile brain than to take the trouble to read a play to get one. Other dramatists frequently reworked his plays, however. Let us not forget that Lope was not the only prolific producer of his time. Tirso de Molina wrote more than 400 *comedias,* Guillén de Castro wrote 43, Vélez de Guevara more than 400, Pérez de Montalbán, Lope's first

biographer, 50 or more, Rojas Zorrilla 60, as well as 15 *autos* and 2 farces, Augustín Moreto wrote about 100, Quiñones de Benavente wrote 900 short comic pieces, and Calderón wrote 120 dramas, 80 *autos,* and 20 comic interludes.[21] In fact, any single play of the period should be judged with an eye to the background of four or five thousand other plays.

Scarcely a single tragedy is found in all this great deluge of plays. Lope set the form as tragicomedy and other authors followed his lead. He says: "Let the tragic and comic be mixed; make one part serious, another ridiculous, for this variety is very delightful; Nature gives us a good example for She attains beauty through such variety."[22]

As regards the three famous unities, Lope recommends the unity of action,[23] though he violates it at times. But he says that it is not at all necessary for the action to take place in a period of one day.[24] The action should take place in the least time possible considering the subject, except in historical plays in which the passage of time is not important. As for the unity of place, if it is necessary for a character to make a journey, let him make it, "a thing which offends the people who follow Aristotle's precepts," but, he adds: "if one is offended, let him not go to see them."[25] Lope argues this as a practical necessity, for he says: "The anger of a Spaniard seated (in the audience) is not appeased unless you show him in two hours everything from Genesis to the Judgment Day, so I find that, if one is to please, that which succeeds is the most just."[26] In other words, nothing succeeds like success.

Another contribution of Lope was the reduction in the number of acts to three. Torres Naharro had used five acts according to the classic precept. In the last half of the sixteenth century most writers had written one-act plays or had

made no division into acts at all. Some had used four acts. Lope popularized the three-act play. His usual technique is to introduce all characters in the first act and involve the plot more and more until the middle of the third act when the solution begins. But, he warns us: "Do not permit the solution until the last scene arrives, because, when the rabble finds out what the end of the play is, they turn their faces to the door."[27]

Lope doesn't always follow his own advice in this respect. Due to his hurried composition his last acts are frequently weak.[28] The demand for new plays was so great that revision was impossible. Plays seldom ran more than a week, and Lope tells us elsewhere that he composed a hundred of his plays in the space of twenty-four hours each. The Spanish audience wanted action, a complicated plot, and a dénouement. They cared little about the delineation of character or psychological analysis. The make-up of the troupes of players, too, had its influence. Troupes were licensed by the government (there were twelve in 1615), and they consisted usually of three "gentlemen," three "ladies," one clown, who was nearly always the servant of the leading male character, his female counterpart, servant of the leading lady, one old man, and three or four handy men who could play minor parts: soldiers, ruffians, servants, etc. When a troupe was putting on a new play every week or so there was little time for rehearsal, so the characters had to be kept more or less the same in all plays. When an actor played the same part all the time he could get along fairly well with his new lines by improvising when he got into trouble. The dread of the whistle of the "illustrious senate," for such the rabble was commonly called, must have encouraged the actors to do their best at memorizing their lines. Even so, the prompter must have been a busy man.

Lope goes on to recommend that "Very few times should the stage remain empty, without a person speaking, for when this happens the rabble becomes restless and the story is greatly prolonged."[29] that is, it takes considerable time to get the audience quieted down so that the show can go on.

One critic has aptly remarked that it is easier to praise Lope than it is to understand him. He knew Latin well, more than a little Greek, and considerable Italian. He also seems to have had an average acquaintance with knowledge in many fields.[30] He, as well as many other poets of his day, borrowed many words from religion such as "altar," "confessor," "glory," "grace," "heaven," "hell," "immortal," "angel," "seraphim," which become a usual element in erotic poetry. In the *comedia* he uses such words in profusion, making the divine descend to the human, not, however, raising the human to the divine. Sometimes, words of religious origin are also used for burlesque, comic effect by the *gracioso,* such as *"fraila de Mahoma," "sacristán de luteranos." Fraila* is an imagined feminine of *fraile,* "monk," therefore "monkess of Mohammed," "Lutheran sacristan." The religious poems, *autos,* lives of saints, singularly enough are relatively free of religious words. For example, in "The Shepherds of Bethlehem" he designated the Holy Virgin by *"niña,"* "girl," *"pastorcilla,"* "little shepherdess," and *"morena graciosa,"* "graceful brunette."

Lope, like most priests of his day, probably believed somewhat in astrology, though he did distinguish between astronomy and astrology, both of which were expressed by the same word. He uses astronomical terms in great profusion, often to indicate the passage of time. Such use in the *comedia* reveals a more or less widespread interest in the subject by a fairly extensive public. Medical terms, too, are rather frequent, though they are used in the current sense rather

than the scientific one. For example, love is frequently compared to a fever. Many birds and animals are also mentioned, sometimes with minute descriptions in the technical language of zoology. He also describes imaginary and exotic animals. References to animals often offer difficulties to the modern reader as for example, *"un título camaleón,"* "a chameleon title." The chameleon, according to popular belief, existed on air, therefore, "a vain or empty title." He borrows words also from botany, aesthetics, architecture, and music. Of course there was a great variety of names of colors. Color symbolism is extremely common in all authors of the time. White was used for purity, dark red for love, pink for cruelty, orange for faithfulness, black for sorrow, gray for sadness, bright red for shame, brown for difficulty, blue for jealousy, turquoise for pride, yellow for despair, green for hope.[31] Sometimes he uses the name of the emotion instead of the color. Thus "cruel lips" might mean simply "red lips," "jealous eyes" simply "blue eyes."

His language as a whole is composed of widely varied elements.[32] Accumulations of special words occur, however, only in works destined for a lettered public. In the *comedia* his language reflects that of the elegant social class of his age, the *gracioso* using any sort of language so long as he is funny and satirical and not difficult for his audience to understand. Sometimes the *gracioso* speaks in a sort of pig-Latin, Latinized Spanish. Perhaps I should point out that the character of the *gracioso* was one of Lope's most interesting innovations. He was a sort of combination of the anti-hero of the picaresque novel plus the common sense of a Sancho Panza. He wanted to avoid trouble when possible, he would much rather run away than fight, he was usually hungry or sleepy or tired. He was always very intelligent, full of tricks, and always giving advice. He was faithful to

his master, though he had an overwhelming distrust of love and women, especially veiled women. All in all, he represents the point of view of the rabble in the audience. He is scornful, witty, and not above asking for a reward before he tells his master some bit of good news.

As to the use of elegant language, Lope advises in the *Arte Nuevo*: "Do not waste thoughts and concepts on domestic scenes . . . but when the person that you introduce persuades, advises or dissuades, then you should use sententious words and concepts, because, doubtless, one thereby imitates the truth, for when a man advises, persuades or dissuades he speaks in a different style from his usual one."[33] Perhaps the interpretation of these concepts, and the plays of Lope are full of them, causes the modern American reader more trouble than any other feature of the language. We must not consider them artificial and silly, however. We must remember the Spanish taste for bombastic language, sonorous epithets, and extravagant similes. Let me cite one or two examples of *conceptos*: in "Struggle on unto Death," Macías, the unsuccessful lover, is speaking to his servant. He says, "Have you never seen a fire? Thus the house of my soul was burning, and then blind understanding begged with a thousand supplications from the fountains of the eyes water to temper the fire."[34] He means that on seeing his sweetheart engaged to another man, he wept and then felt better. Often a play on words is made using the name of a character. In "Punishment Without Vengeance" one of the female characters has the name Aurora. The following dialogue occurs:

FEDERICO. That is not Aurora; you are mistaken.
CASSANDRA. Well, who is it?
FEDERICO. The sun itself;
For I find that it often dawns from these Auroras.[35]

Lope is very insistent that this sort of language is effective. In another play he makes fun of works "in which carpentry is substituted for concepts and intrigue."[36]

Lope also recommends "deceiving with the truth" and "equivocal speech," for he says, "each individual of the rabble thinks that he is the only one who understands what the actor means."[37]

As to the length of plays, "they should not be so long as to try the patience of the audience."[38] As a matter of fact they average from 3,000 to 3,200 lines. Many of the editions which have come down to us are very defective, for an author sold a manuscript outright to a producer, who, if the play promised to be successful, had it printed in pamphlet form. There was a convention among printers that no play should be longer than thirty-two double column pages.[39] If a play should be longer than this they simply cut it down. The producers, too, often made changes which they thought desirable, so that we have little assurance in reading one of these pamphlet editions that we are reading what the author actually wrote. A still more vicious practice was that of pirating plays. We often read of a man called Gran Memoria, "great memory" who could attend one showing of a play and remember enough of it to write it down and sell it to a printer. These editions, of course, are particularly corrupt.[40]

As to the most popular kind of plays, Lope truly says, "Affairs of honor are the best because they forcibly move all people; . . . for virtue is beloved everywhere and we see that, if perchance an actor plays the rôle of a traitor, he is so odious to everyone that people will not sell him what he wants to buy, the rabble flees from him when they meet him; but if he is loyal they lend him money, and invite him out and even the nobles honor and love him and seek after

him, regale him and acclaim him."[41] Lope is referring here to the so-called cape-and-sword play which he invented and which was the most popular type all through the Golden Age. The honor code seems to us who live in modern times and in a democratic country, artificial, cruel, illogical. But in seventeenth-century Spain it was almost a religion transcending the Christian religion and that in a country and a time noted for religious fanaticism. If a man were to fight a duel he risked not only his life but what was more important his soul as well; and this happened often because of affairs which we would now consider insignificant. In fact the government found it necessary to outlaw duelling and a third risk was created, that of being punished by the courts.

Honor[42] was conceived as the reputation which a man had among his peers. The nobility were endowed with honor *per se*. Honor, however, could be acquired by doing deeds generally approved of, such as performing brave deeds in the army. It could be increased but not diminished. It could only be lost entirely. Commoners who spoke of their honor were generally laughed at. Yet commoners in positions of authority, such as the mayor of a city, were esteemed as were members of the nobility.

Honor was a man's most valued possession, far surpassing love or wealth. In fact, life without honor had no meaning whatsoever.

Anything which tended to lower a person in the estimation of his fellows constituted an insult and consequent loss of honor. For instance, if, by bribing a servant, a man succeeded in gaining entrance to the house of a lady who had scorned him, she and all the male members of her family automatically lost their honor. Nor was an overt act of this sort even necessary; a mere statement, true or untrue,

uttered publicly was sufficient. For example in "The Doctor of his own Honor"[43] Margarita seeks justice from the king because don Jacinto had deserted her on the eve of their marriage. She is informed that he did so because he suspected her. She thereupon drops the complaint. Her honor is lost and she enters a convent.

An offense to one's honor must be washed out in blood. Strangely enough, duels were the result of only minor offenses. The adulterous wife was murdered, or executed, if you like, but secrecy was indispensable. If the wronged husband could so devise his vengeance as to punish the other man also, so much the better. But the main thing was to keep the matter secret, for the more people who knew of the offense, the greater the dishonor.

The king, being able to create nobles, was superior to questions of honor between his subjects. A man had no recourse when dishonored by the king. He owed the king his complete loyalty: his life and, what was greater, his honor. Lope and most other dramatists, usually avoided the situation in which the king wronged a subject. There was too much danger of offending the ruling monarch and, furthermore, the king was conceived of as God's representative on earth, and as such, practically incapable of a dishonorable action. Such was the monarchical sentiment of the age.

The long-continued popularity of honor plays is ample proof that this conception of honor was not an invention of dramatists but a belief held by a majority of the people, and it even had the approval of the Church, which surely cannot be accused of radicalism. The Spaniards have always had the reputation of being extremely touchy on points of honor. What was the cause of this? There are probably two reasons. First, the people, and particularly the nobility, were a homogeneous group, with religion as a nucleus. Political

thought, too, was highly centralized. Lack of conformity to existing standards was very seriously regarded so that the force of public opinion was greater than in a country containing relatively large groups of dissenters.

Next to honor, love was the most important motive of the cloak-and-sword play. Most honor situations arose from some phase of the relations of men and women. Again we should try to understand the attitude toward love if we are fairly to judge a play in which love is a principal element. To us, most of the men of Golden Age plays seem to be egotistical, overbearing, insanely jealous, and none too fair in their dealings with women, who in turn seem to be rather spiritless, supine creatures, all too ready to give in to the man's desires.

It is well known that Spanish girls were closely guarded before marriage and that courtships had to be carried on in a clandestine fashion. Marriages were arranged by parents, with or without the consent of the young people. In any case, the young man and the young woman seldom if ever became well acquainted before they were married. After marriage, the husband was definitely the head of the house. Now the attitude toward love, as exhibited in the Golden Age drama is entirely from the man's point of view, an attitude which Doctor César Juarros, a present-day Spanish psychiatrist terms the "national masculine sentiment."[44] He believes that it is still the prevalent attitude among all except the most highly refined people of the upper classes and that it is the main cause of most marital difficulties. Dr. Juarros finds that there are five basic ideals which go to make up the "masculine psychology": the infidelity of the wife constitutes a dishonor; woman is inferior to man; the more women a man has possessed, the more manly merit; one truly in love must be jealous; to buy love is not humiliating.

The first of these ideas we have taken up in dealing with the honor question. As regards woman's inferiority, we find men taking the attitude that the woman to whom he takes a fancy should fall in love with him at once, in fact she should feel highly complimented that he has deigned to notice her. When two men take the same notion at the same time there is inevitably a conflict. This is a stock situation. Do not be surprised if a man upbraids his sweetheart for her inconstancy, even when he has no reason to do so whatsoever. That merely proves that he loves her. One way to gain a woman's love was to flatter her father or brother with promises of honors or authority. The fathers and brothers seem to be rather willing to give their consent, too, and once they have pledged their words they cannot back down. Now in case the woman loves another, the solution is rather difficult. It usually involves the removal of the villain in some way or other.

Lope also made use of popular songs,[45] sometimes incorporating them in the plot, sometimes interpolating them bodily, usually re-working, and polishing them. He surely composed many of them himself. He had a peculiar knack of imitating popular poetry and it is often difficult to tell what he wrote himself and what he simply included. The situation is further complicated by the custom of the time of leaving the choice of a song to the producer of the play and in many cases, when Lope did not revise a play before publication, the songs may have been the ones included by the impresario on his own initiative.

Lope also popularized the "little story."[46] These stories were used for comic effect and usually related by the *gracioso* to prove some point he had made. One or two examples will give a sufficient idea of them. A captive bargained with the king to teach an elephant to speak before a period of ten

years had elapsed. Upon being asked privately why he had made such a rash boast, he replied: "Within ten years either the king, the elephant, or I will be dead."

In another play a monarch, before besieging a certain city, gave permission to the women to carry out anything they could bear on their backs. They carried out their husbands.

Another example: The wives of Roman senators boast that they are the strongest in the world: Rome is mistress of the world: its senators rule Rome: the senators are ruled by their wives.

Just one more: The servant of an astrologer made true prognostications by writing the opposite of his master. After his master died the servant ceased his predictions for he could predict only by contradicting his master.

Like other poets of the Golden Age, Lope's reputation waned during the eighteenth century, the period when the neo-classic spirit was felt most strongly in Spain.[47] The romantics, generally speaking, were the first to give attention to the Golden Age theatre, but Lope received the scantiest attention of all. Until relatively modern times Calderón was considered to be the supreme dramatist of the period. Recent critics, however, have placed Lope in the place which he deserves in the history of Spanish dramatic literature and today we recognize that it was Lope, who, by respecting the elements of militant patriotism, religious fanaticism, respect for family traditions, points of honor, taste for sonorous verse, elements deeply rooted in the national consciousness, brought order out of chaos and almost single handed established a popular national theatre.

Joseph E. Jones.

NOTES

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[12]*Arte nuevo de hazer comedias en este tiempo.* The best text is that of Morel-Fatio included in H. J. Chaytor, *Dramatic Theory in Spain* (Cambridge, 1925), 14–29.

[13]*Arte nuevo,* ll., 40–48.

[14]*Ibid.,* ll., 134–35.

[15]Emilio Cotarelo, Prologue to the Academy edition of Lope de Rueda, *Obras.*

[16]Rennert y Castro, *Vida de Lope de Vega,* 113–32.

[17]An approximate equivalent of the 140–200 *reales* of Rennert y Castro. The buying power of money in late sixteenth-century Spain, too, was somewhat greater than in present-day America.

[18]Lope de Vega, *Porfiar hasta morir,* ll., 3–5.

[19]H. J. Chaytor, *Dramatic Theory in Spain,* Introduction, xi–xii.

[20]*Arte nuevo,* ll., 157–58.

[21]M. Romera-Navarro, *Historia de la Literatura Española* (Heath, 1928).

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[26]*Ibid.,* ll., 205–10.

[27]*Ibid.,* ll., 231–39.

[28]James Fitzmaurice-Kelley, *Chapters on Spanish Literature* (London, 1908), p. 182.

[29]*Arte nuevo,* ll., 240–43.

[30]L. Salembien, "Le vocabulaire de Lope de Vega," *Bulletin Hispanique,* XXXIV (1932), 97–127, 289–310; XXXV (1933), 51–69, 368–91.

[31]On color symbolism see: H. A. Kenyon (*romances*) in *Romanic Review,* VI (1915), 327–40; S. G. Morley (Tirso) *Romanic Review,* VIII (1917), 77–81; W. L. Fichter (Lope) *Romanic Review,* XVIII (1927), 220–31; Barbara Matulka (fifteenth century), *The Novels of Juan de Flores* (New York, 1931), p. 266 ff.; and E. Buceta, *Bulletin Hispanique,* XXXV (1933), p. 300.

[32]L. Salembien, *op. cit.*
[33]*Arte nuevo,* ll., 250–56.
[34]Lope de Vega, *Porfiar hasta morir,* Act II, Scene XI.
[35]Lope de Vega, *Castigo sin venganza,* Act II.
[36]*Ay verdades que en amor.*
[37]*Arte nuevo,* ll., 319–26.
[38]*Ibid.,* ll., 338–40.
[39]H. J. Chaytor, *Dramatic Theory in Spain,* note p. 27.
[40]*Loc. cit.*
[41]*Arte nuevo,* ll., 327–37.
[42]A. Castro, "Algunas observaciones acerca del concepto del honor en los siglos XVI y XVII," *Revista de filología española,* II (1916), 1–50, 357–86.
[43]*El médico de su honra.*
[44]*El amor en España* (Madrid, n.d.).
[45]Lope de Vega, *Cancionero teatral,* prólogo y notas de J. Robles Pazos (Johns Hopkins Press, 1935).
[46]Milton A. Buchanan, "Short Stories and Anecdotes in Spanish Plays," *Modern Language Review,* IV (1908), 178–84, V (1909), 78–89.
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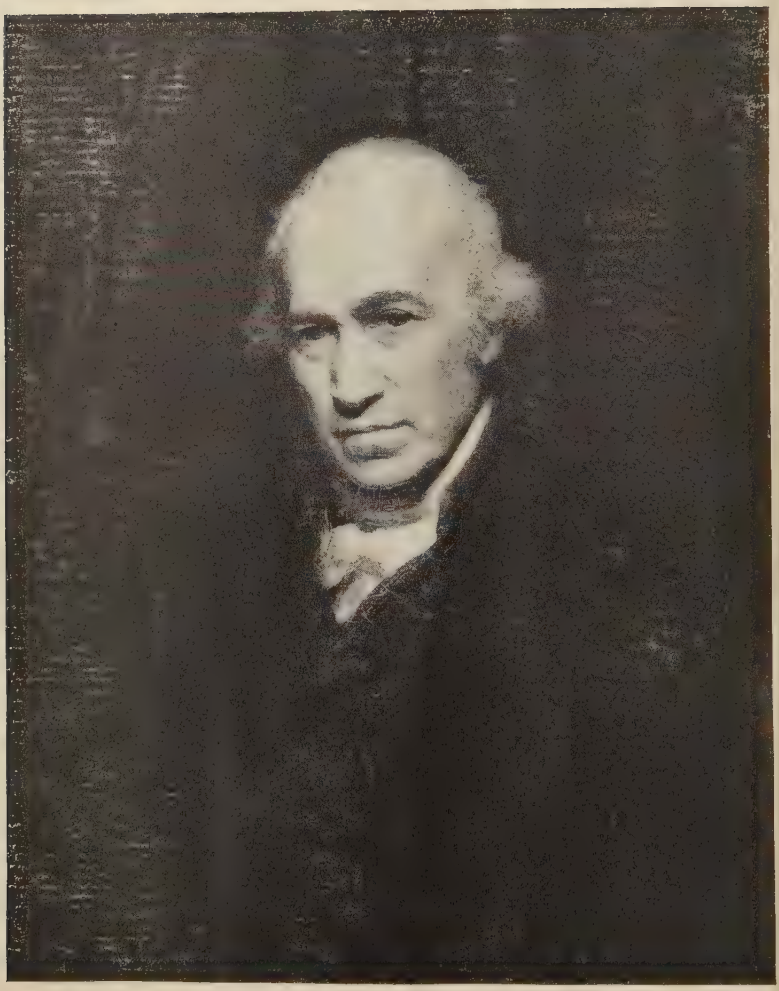

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Figure 1. Portrait of Watt in his 66th year

IV

BICENTENARY OF JAMES WATT, PIONEER OF THE STEAM ENGINE[1]

IN 1711, an English blacksmith was doubtless experiencing that mixture of fear and pleasurable anticipation which always comes to a man about to test on a commercial scale an idea over which he has worked long and hard. In this case the idea was the use of heat from fuel to drive a water pump, with steam serving as a working medium. No one had as yet really used fuel as a source of work on a commercial scale, although there was a strong demand for an addition to the world's sources of power. For centuries, these sources had been limited to flowing water (which was not often available where and when wanted), to the still more unreliable wind, and to expensive slave and animal labor. Those sources permitted a standard of living in Europe which seems decidedly simple today; but the maintenance of even those standards was in 1711 becoming a serious problem in certain fields. The difficulties were especially noticeable in mining, where deeper workings caused more and more trouble with hoisting and pumping; so this inventor had worked for a number of years on a device he hoped would supersede horses as a motive power for unwatering mines. At last certain owners of a coal mine, harassed by expenses for hay, oats,

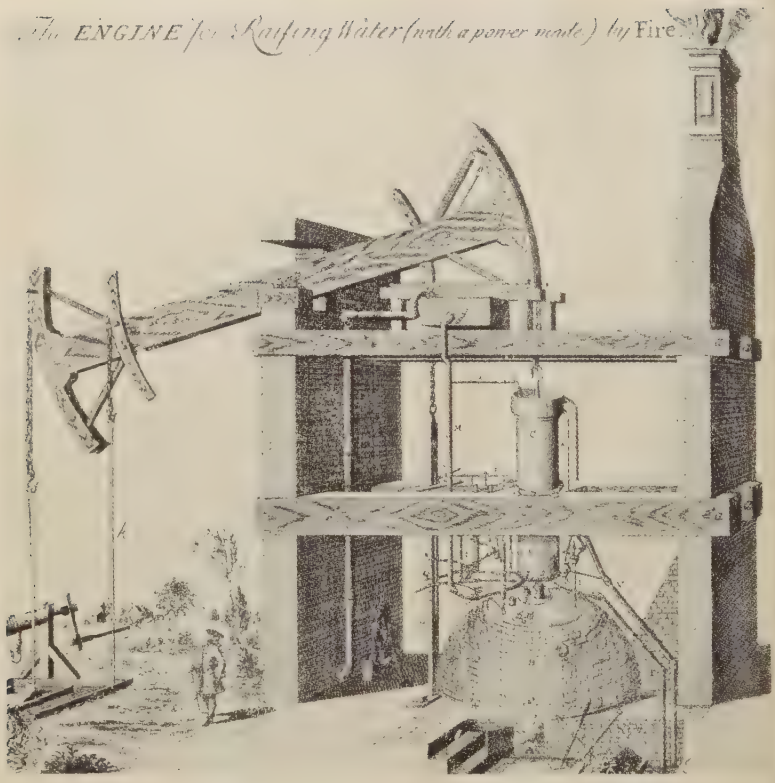
[1]Of the illustrations appearing in the course of this lecture the author is indebted to the courtesy of the Newcomen Society for No. 2 and of the University of Glasgow for No. 3, while Nos. 1, 4, 5, 6, and 7 are reproduced from *James Watt and the Steam Engine* by the kind permission of Messrs. Dickinson and Jenkins.

and worn-out horseflesh, had authorized him to supply their colliery with one of his fire-engines.

The machine to which his hopes were pinned consisted of a boiler generating steam at atmospheric pressure, a vertical cylinder closed only at the lower end and containing a single-acting piston chained to one end of a walking beam, and a reciprocating pump attached to the opposite end of the beam. We do not know exactly how this first engine operated, but apparently its cycle was something like this: the piston being held at the upper end of its stroke by the weight of the pump rods, steam was admitted to the cylinder. Then the steam valve was closed and water was sprayed on the outside of the cylinder, causing condensation of the steam and the formation of a vacuum below the piston. Atmospheric pressure acting on the upper face of the piston forced it down, thus lifting the pump rods and the water in the pump cylinder. Next, opening a valve at the bottom of the cylinder drained the condensed steam back to the boiler by gravity and supplied a fresh cylinder full of steam at atmospheric pressure, equalizing the pressure on both sides of the piston. The weight of the pump rods then lifted the piston, and with the closing of the valve the engine was ready for another cycle. Because the piston always leaked, a layer of water was provided on top of it to prevent the leakage of air from spoiling the vacuum in the cylinder.

This layer of water was responsible for one of the first improvements applied to this machine. An engine was discovered running much more rapidly than usual. Investigation showed a crack in the piston which allowed cold water to enter the cylinder, thus forming the vacuum more rapidly than before. Thereafter, the cooling water was sprayed into the cylinder itself instead of on its outer surface.

Since the motion of the piston was due to the pressure of



Courtesy of the Newcomen Society

Figure 2. Drawing of Newcomen engine made by Beighton in 1717

the atmosphere, this engine is often termed an atmospheric engine; and because the force per square inch could never be great, the diameter of these pistons was always large—usually between thirty and sixty-six inches.

The builder of this engine, Thomas Newcomen, soon had good reason to be pleased with his invention. He had customers for three more engines in the next three years, and before his death some eighteen years later he had seen them widely adopted all over Europe for pumping at coal and tin mines. Legend says that in 1713 a lazy boy named Humphrey Potter lost his job of turning the steam and water valves because he tied the handles of these cocks to the beam by cords, thus making the engine entirely automatic and capable of fifteen or sixteen strokes a minute instead of six or eight. More reliable information tells how in 1718 Henry Beighton, later a Fellow of the Royal Society, invented the first substantial steam engine valve gear by hanging from the walking beam a heavy rod called a plug tree which carried tappets operating the valves. This construction was used with all kinds of steam engines for over seventy-five years, or until the application of the eccentric to the valve motion about the year 1800.

A drawing made by Henry Beighton himself in 1717 gives a good idea of the Newcomen engine of that date. It is single-acting, with a mechanical valve gear and with water injection into the cylinder, and it has a piston two feet or more in diameter, sealed by water from an overhead tank. This engine was being promoted on the market by an organization known as "Proprietors of the Invention for Raising Water by Fire"; and in the years 1720 and 1721—the years of the South Sea Bubble collapse—two verses of doggerel give a hint of the stock-selling activities of the Proprietors. One verse, from "The Broken Stock Jobbers" says:

Why must my stupid fancy e'er admire
The way of raising Water up by Fire?
The cursed Engine pumped my Pockets dry
And left no Fire to warm my fingers by.

The other verse, from "England's Folly," urges:

Come all ye Culls, my Water Engine buy,
To Pump your flooded mines and Coal-pits dry.
Some projects are all Wind, but ours is Water,
And tho at present low may rise here a'ter.

Since all of these developments occurred well before the birth of James Watt on January 19, 1736, just a few weeks over two hundred years ago, it is obviously wrong to state (as is sometimes done) that Mr. Watt invented the steam engine. In fact, at least three men had contributed to the idea before Newcomen built the first commercially successful engine with piston and cylinder.

In 1663, the Marquis of Worcester described hazily a steam pump which he claimed worked very well. Then in 1690, the field was entered by Dionysius Papin, a religious refugee who found employment in London as a demonstrator before the Royal Society. In his attempts to design a steam pump, he used a cylinder containing a piston floating on top of the water to be displaced. Steam at a small pressure above atmospheric was his source of power. None of his engines received any commercial application.

But in 1698, an English army engineer, Thomas Savery, secured a patent on a partially successful steam pump. It was composed of two chambers in which vacuum and steam pressure were used alternately to suck in and to discharge water, much as is done in the modern pulsometer. This pump contained no pistons. The steam pressure acted directly on the surface of the water, and the vacuum was secured by pouring water on the outside of the vessels. Both these conditions made the steam consumption very high. Moreover,

the height to which it could discharge water depended upon the pressure of the steam it could command; and since this pressure was seriously limited by the weak boilers available, Savery's pump could not be used in deep mines. Newcomen's engines did not require high pressure steam; in fact, their boilers are said to have operated sometimes with manholes open to the air. In general, Savery's pumps had only small commercial success; so he combined his efforts with Newcomen, who lived only fifteen miles away. Certainly he deserves some of the credit generally given Newcomen, whose special contributions include the beam which for over a century was characteristic of commercial steam engines.

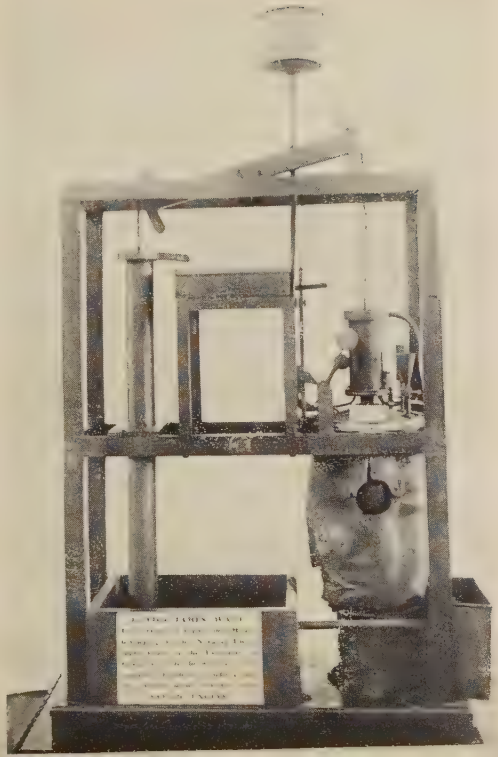
The economic value of the Newcomen engine is indicated by a description of conditions in a French mine in 1739. Before the erection of an engine, the labor of fifty horses and twenty men working twenty-four hours a day was necessary to keep the mine dry, but the engine and one man could do as well by working only forty-eight hours a week. It is not strange that the engine's popularity extended even to the British colonies in North America, where in 1753, when Watt was only seventeen, the first steam engine on this continent was installed in a New Jersey copper mine.

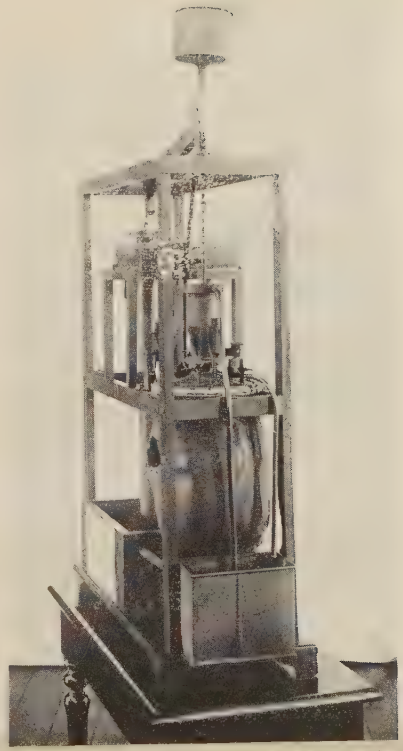
However, the atmospheric engine had three serious defects: first (and worst), the periodic cooling of the cylinder condensed so much hot entering steam that the coal consumption was extremely high, allowing the engine to be used only in places where fuel was cheap; second, its power output was small—usually less than 100 horsepower—because the force on its piston was small, its piston was single acting, and its cycle was performed slowly; and third, a good method of driving rotary machinery, such as shafting, was not known. This last condition practically excluded the engine from driving manufacturing plants, textile mills, flour mills, and the

like. The fault was attacked by pumping water into an elevated tank, whence it flowed into an over-shot water wheel which supplied the rotary motion. Of course, such an arrangement was inefficient; it probably wasted half the engine's output in pump and water-wheel losses; but the engine with connecting rod, crank, and rotating shaft was not developed until 1780, when the Newcomen engine was about seventy-five years old and almost obsolete. All its life, the atmospheric engine was limited to pumping service; and because of its high fuel consumption and its jerky unequal strokes, it did not monopolize even that field. Water power and horses continued to be the real prime movers. Newcomen engines helped the miners and were pointing the way to better things, but they could not possibly meet even the eighteenth century's demand for mechanical energy.

Such was the power situation in 1763, fifty-two years after Newcomen's first commercial installation of a steam engine, and ten years after the erection of the first steam engine in America. In that year, James Watt, a young instrument maker employed by the University of Glasgow, received the task of repairing the model of a Newcomen engine owned by the University. From the speculations induced by this repair work followed the interest of James Watt in steam and steam engines and to a great extent the creature comforts we enjoy today.

Possibly some of this audience would trace Watt's interest in steam back to an earlier date—back to a time when as a child he is supposed to have watched the tea-kettle lid bob up and down, inspiring him with hopes of harnessing the giant within to the service of mankind. This legend, like several others relating to Watt, is based on quite shaky ground. It seems to have originated from some very different recollections dictated by a cousin fifty-odd years after the sup-





posed occurrence and long after Watt had become famous enough to encourage reminiscences of his boyhood. Possibly it is even an adaptation of a story relating to the Marquis of Worcester, who while taking an enforced vacation in the Tower of London is said to have drawn similar inspiration from the pot in which his dinner was cooking. The same story is told of Newcomen too; in fact, for many years a mantel was preserved in England beneath which Newcomen's inspiration was said to have bubbled.

A second Watt legend resting on insecure foundation is that the University of Glasgow prevented the exclusion of Watt from that city by the trade guilds, who argued that he had not served a legal apprenticeship and was not the son of a Glasgow burgess. The records of the Glasgow Incorporation of Hammermen are completely silent on this point, and as a matter of fact Watt opened a small repair shop and retail store in Glasgow two years after entering the service of the University. But although these two legends about the tea-kettle and the persecution of the guilds have little basis, there is no doubt about the inspiration furnished Watt by the little engine model, now one of the treasures of the University. In return for his work on it, he received £5 11s. and an impulse which led both to his own fame and to a tremendous increase in the comfort of mankind.

At the time when Watt received this repair job, his circumstances were these: he was twenty-seven years old; he had been instrument maker to the University for six years and had made a number of valuable friends in its science faculty; he was operating a repair shop on the campus, was helping a pottery establishment with its mechanical problems, and was a partner in a retail store in the city which sold and repaired optical and navigating instruments, buckles, buttons, and ornaments. Mending flutes, guitars,

and bagpipes was also a part of the activities of this business, which had a total capital of £200 and from which Watt drew an annual salary of £35. But in spite of all these activities, his total income was quite small. Soon he had the added expense of a wife and children; so the cost of his experiments with steam had to be met with borrowed money. Even time for experiment was hard to wedge into years spent in meeting family expenses and in conserving a rather delicate physique. These limitations on funds, leisure, and health, account for what seems quite slow progress in engine design during the eleven-year period between 1763 and 1774.

The question which the engine model first brought into his head was: Why does this small cylinder drain the boiler of steam in a very few strokes? The condensation of incoming steam due to alternate cooling and heating of the cylinder was the rather obvious cause; but how to avoid this condition puzzled him as much as it had Newcomen and his associates. For months the problem was an obsession to him. In April, 1765, he wrote a friend, "I can think of nothing else but this machine." But the very next month, while on a Sunday afternoon walk in the country, the answer suddenly occurred to him: he must condense the steam in a separate vessel which would be kept cold. A steam pipe and valve would connect it to the cylinder, which would be kept hot.

This idea of a separate condenser is clearly Watt's own and is of the greatest importance. Only by the use of the separate condenser could a reasonable fuel consumption be reached; and without that characteristic, steam machinery would never have given us the faithful service which means so much to our modern comfort.

To develop his idea commercially brought Watt face to face with serious difficulties, both financial and mechanical.

Already he had borrowed money for apparatus from his friend Dr. Black, professor of chemistry at Glasgow University and the discoverer of the latent heat of vapors and liquids; and his attempts at producing a geometrically true engine cylinder were to be failures for a dozen years. But at this juncture help appeared in the person of Dr. Roebuck, a physician friend of Dr. Black. This gentleman had three qualities especially useful to Watt: he was rich, he had a controlling interest in a neighboring foundry and machine shop, and he had a serious need for a machine to replace an inadequate Newcomen pumping engine. His wealth had come from two interesting sources. By amateur experiments in chemistry, he had developed a very profitable lead-chamber process for making sulphuric acid at a quarter of the former cost. From this success he turned to the mining and manufacture of iron, with special attention to artillery and large castings. His plant, known as the Carron Iron Works, gave its name to a very popular short naval cannon known as a carronade. Those of us who visited "Old Ironsides" while she was in port saw a number of them in her armament, though very possibly they did not come from the Carron Iron Works. In mining coal for his furnaces, Dr. Roebuck met the old trouble of flooded pits and found the atmospheric engine wanting. His and Watt's mutual interest was most natural. He urged Watt to push forward his experiments, which concerned the physical properties of steam and the various types of condensers. These tests were made with apparatus still in existence.

But the personal problems interfered seriously. A year after his conception of the separate condenser idea, Watt closed his shop and opened an office in Glasgow as a land surveyor and consulting engineer. For seven years, he divided his time between surveying canals and working on

steam machinery with Dr. Roebuck, who soon agreed to a partnership in which he secured a two-thirds interest by assuming Watt's debts of over £1,000 and the expense of a patent covering the use of steam for power generation. In the summer of 1768, Watt applied personally for this patent and on his way home from London stopped at the factory of one of England's most prominent manufacturers, Matthew Boulton, a maker of buttons, knee and shoe buckles, steel watch chains, sword hilts, and plated ware. This experienced, optimistic, generous business man was to have an influence on the early development of the steam engine second only to Watt, who always called on Boulton for help whenever he faced business troubles. Boulton's factory employed close to a thousand men and probably was the largest in the world. But it was suffering from a very prevalent complaint: lack of water power to turn its machinery in the summer. Watt's new plans and his personality induced Boulton to negotiate for the purchase of Dr. Roebuck's interest. But the doctor was so optimistic that he not only held his share but financed the construction of a large engine on his property, with many of the parts supplied by the Carron Iron Works.

A drawing made by Watt himself late in 1768 indicates his ideas at that time. This design shows a single-acting engine with a beam; the upper side of the piston is always exposed to the boiler pressure; the lower end is connected alternately to the boiler or to the condenser by a hand-operated oscillating slide valve. The condenser is just a water-jacketed pipe, and the condensate pump is a simple affair worked from the beam. The engine for Dr. Roebuck was probably much like this drawing. We know it had a cylinder of tin eighteen inches in diameter and a quarter of an inch thick and that in one place the bore was three-eighths of an inch out of round.

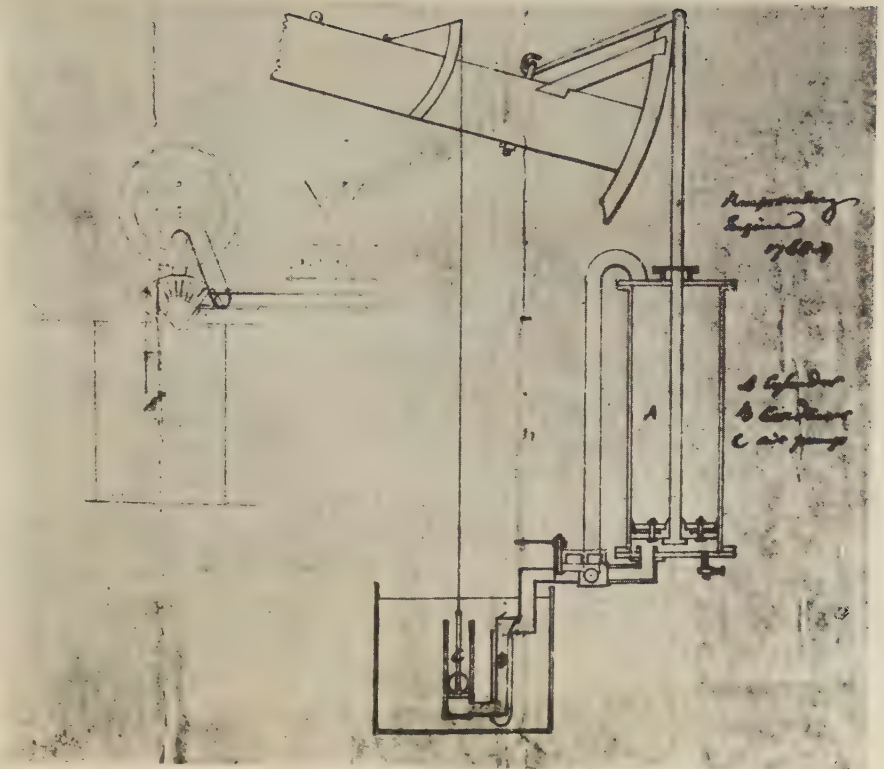


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Figure 4. Drawing made by Watt in 1769

Considering this last fact, it does not seem strange when a letter from Watt mentions as a fine job a piston fitting its cylinder within one-sixteenth of an inch all around.

With this large equipment tests were made both on the engine and on various condensers; but in the spring of 1770 work stopped for over three years. At first, Watt's canal duties interfered. He found this work reasonably profitable and interesting, and he had enough leisure to make at least two new inventions. He developed and used in his work the system of stadia measurement of distances taught to every land surveyor today, and apparently he was the first man to do so. He also described in correspondence his construction of an instrument for measuring extremely small fractions of an inch, and if the micrometer found among his tools after his death is the one of which he wrote, he probably deserves credit for inventing that extremely useful device. Had financial conditions in Great Britain been favorable, his temporary abandonment of the steam engine might have been permanent, and he might easily have developed into a distinguished civil engineer rather than into a recognized mechanical genius. But in his country the years 1772 and 1773 were those of a severe depression caused by bad harvests, commercial speculations, and very general bank failures. Canal building stopped, but so did Dr. Roebuck's contributions for engine development. In writing to a friend about future employment, Watt gives this interesting picture of himself: "I am also indolent and fearful, terrified to make bargains & I hate to settle accounts. . . . Remember in recommending me to business that what I can promise to perform is: to make an accurate survey & a faithful report of anything in the engineer way . . . to assist in the bargaining for the price of work; to direct how it ought to be executed. . . . But I can on no account have anything to

do with workmen, cash, or work-men's accounts, nor would I chuse to be bound up to one object that I could not occasionally serve such friends as might employ me for smaller matters. I am not a man of regularity in Business & have bad health. Take care not to give any body a better opinion of me than I deserve, it will hurt me in the end."

He was greatly distressed over the misfortunes of Dr. Roebuck, who was definitely insolvent in 1773; but out of the wreck of his fortune came advantages to Watt and through him to the world. Matthew Boulton, who was a creditor, accepted the Doctor's interest in the steam engine as payment of his claims, and Watt was allowed to keep the large engine, which the other creditors considered absolutely worthless. An informal unwritten partnership between Boulton and Watt was promptly arranged; Watt closed his engineering office; and nine years after the conception of the separate condenser idea, both Watt and the experimental engine moved to Birmingham for a period of intensive development, under an arrangement which allowed Watt for the first time to give his whole attention to the steam engine.

These earlier delays had one effect which threatened to be serious. Six years of his patent protection were gone, and the remaining eight promised to be too few for securing enough income to meet development expenses. This fact and the inadequacy of tin as a cylinder material were two conditions receiving much attention in the autumn of 1774. In consequence, early in 1775 a cast iron cylinder was ordered, and Watt went to London to lobby for an Act of Parliament extending his patent twenty-five years. Both were secured by summer, and a new pumping engine was built in Boulton's factory. It had a cylinder diameter of eighteen inches and a stroke of five feet, used a surface condenser, and made about fifteen strokes a minute. As in the drawing of 1768

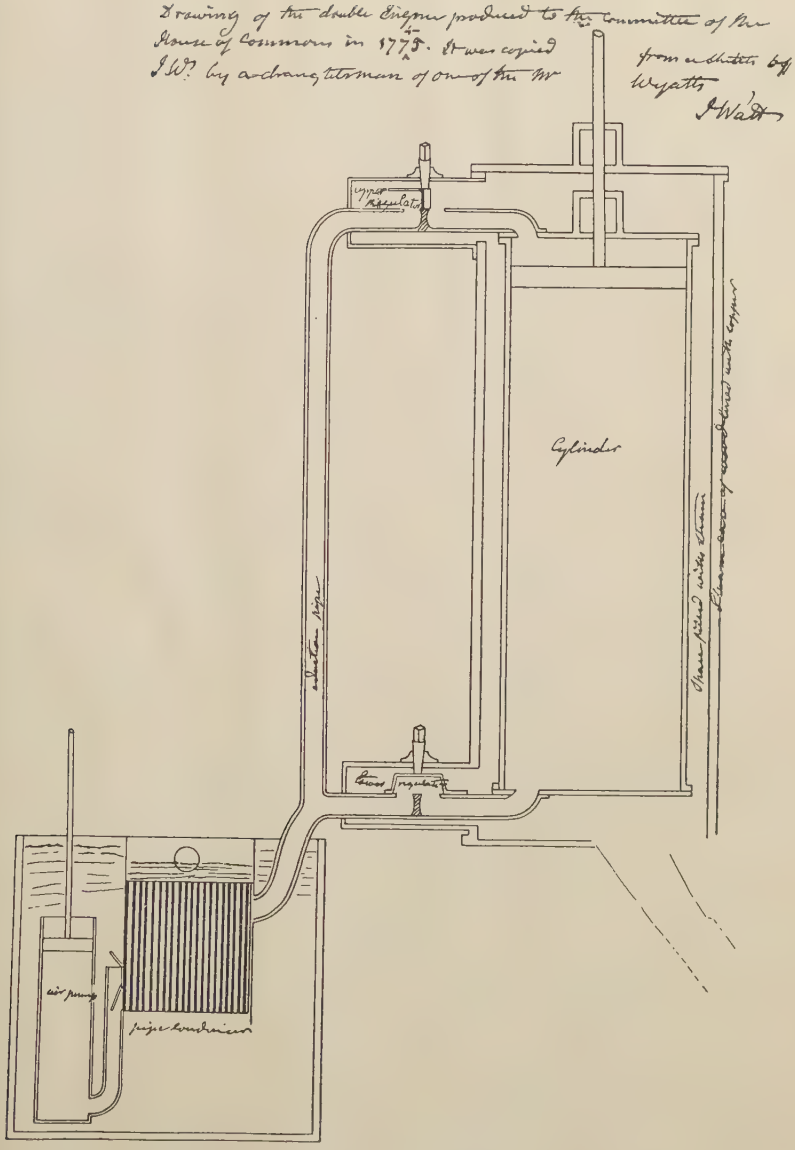
Drawing of the double Engine produced to the Committee of the House of Commons in 1775. It was copied J.W. by a draughtsman of one of the Mr
from a sketch by Wyatt
J. Watt
Cylinder
air pump
jet condenser

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Figure 5. Drawing made by Watt in 1775

boiler pressure always occupied the upper face of the piston. For half a dozen years, all sorts of new ideas were tried out on this engine.

By midsummer, Boulton and Watt were working feverishly on an engine for their first customer. A famous ironmaker, John Wilkinson, needed an engine to blow air into his blast furnaces, and he placed order number one. Wilkinson was a remarkable man in several ways. His first invention, a smoothing iron much used for pressing the ruffles so popular in the dress of that day, was followed by many others, including the first iron bridge, the first iron barge, and the first machine for boring cylinders with real accuracy. His interest in iron was carried to eccentric lengths. Every letter he wrote was required to contain the word iron; he built an iron chapel containing an iron pulpit; his coffin and his funeral monument were iron. His boring machine was of the utmost importance to Watt, many of whose early delays had been due to poor cylinders. The best boring machine prior to 1774 carried its cutters on a disc too flimsily supported to form a true cylinder; but by mounting the cutters on a radial arm carried by a heavy shaft rotating in stationary bearings, Wilkinson did work which Watt described in these enthusiastic terms: "Wilkinson can bore 72 inch cylinders within the thickness of a thin sixpence." This invention appeared at exactly the right time for Watt, for it is very doubtful if his or any other man's engines would have been a commercial success without the aid of Wilkinson's boring bar.

Both this engine and a coal-mine pumping engine with fifty-inch cylinder and seven-foot stroke went to work in March, 1776. Their superior fuel consumptions attracted a large number of orders and inquiries. In fact, during the summer of 1776, while Boulton's friend, Benjamin Franklin, was helping word the American Declaration of Independ-

ence, Boulton and Watt were making a very good start at the business of liberating millions of men and horses from the drudgery of power generation. Boulton the manufacturer saw clearly that their engines must eventually develop into machines adapted to rotating the shafts of mills and factories; but the most active demand was for reciprocating pumping engines, which were also the easiest type to construct. In consequence, engines with rotating shafts were not attempted for five or six years.

The pumping field alone was sufficient employment to keep Watt extremely busy for several years at designing, drafting, correspondence, and field supervision of engine erection. His method of engine construction was radically different from modern practice. Today, a machine of any sort is usually built in a manufacturing plant and shipped complete to the purchaser; but in 1776 and for twenty years after, Boulton and Watt furnished only drawings and instructions, a few of the more delicate parts made in their factory, the right to operate under Watt's patent, and the services of field erectors who were paid by the customers. Much of the engine was actually built at the plant site. This included the engine beam, the boiler, and all the forged iron work. Other parts usually came from several different foundries or machine shops. Poor transportation facilities were largely responsible for this practice. Trouble was even experienced occasionally with French privateers in the English channel or with ships whose hatches were too small to admit large castings. Working under this system, the cost to the customer of the third engine sold by Boulton and Watt was under £800. In addition to this initial expense, throughout the life of Watt's patent the engine's owner had to pay its makers a royalty of one-third of the fuel savings below the consumption of a Newcomen engine.

The demand for engines and the difficulty of securing

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properly skilled erectors kept Watt in the field many months, especially among the Cornwall tin mines. Ten engines were being constructed in 1777, and the demand for his services caused him to write home, "I fancy I must be cut up in pieces and a portion sent to each tribe in Israel." The superior fuel consumption of the Watt engine is shown by a test made on a twenty-inch engine built in 1777 to pump water in the locks of the Birmingham Canal. This small unit cost its owners £350 erected. It is probably still in working condition, for it was run under steam as late as 1919. When tested in 1778, it used 64 lbs. of coal per hour. But the best Newcomen engine would have used 194 lbs. per hour, or three times as much. If this fuel consumption decrease is typical, it is not strange that in six years Boulton and Watt had erected forty pumping engines and that only one Newcomen engine was left working in Cornwall. By 1779, engines were being exported to the Continent, where they became increasingly popular.

While these customers were being satisfied, many of Watt's other ideas remained untested. One of these was the possibility of the expansive use of steam, a plan which he had discussed back in 1769. To try it out and also to supply more power to Boulton's growing factory, a second engine was installed there in 1777. Its job was to pump water over a water-wheel which drove line shafting. Some of the parts of this engine are still in existence. Its cylinder was thirty-three inches in diameter, its stroke was seven feet, its speed was about twenty strokes a minute, a combination giving something like thirty horsepower. It worked for seventy-odd years in this factory, where it gained the name of "Old Bess." But it did not prove the value of steam expansion, largely because Watt's life-long fear of boiler explosions kept the steam pressure low, partly because the variable pressure in the steam cylinder was not well adapted

to the load of a pump with no flywheel. This lack of a crank and flywheel gave even Watt's beam pumping engine a tendency to fierce and erratic action.

The tremendous press of work which almost crushed Watt between 1777 and 1780 was somewhat eased by one of his inventions which, though now quite obsolete, was indispensable to business for over a century. This was the copying book and press, which took the place occupied today by the typewritten carbon copy. In its use, letters or drawings were placed between moistened tissue paper sheets and the whole mass was squeezed firmly together by a hand-operated press. Enough ink adhered to the tissue paper so that by looking at the back of the transparent paper, a readable copy appeared. Since Watt used this system for making copies of his drawings, he is credited with having developed the first system of reproducing drawings. He patented the process and with Boulton's help manufactured the equipment as a separate enterprise under the firm name of James Watt and Co.

In June, 1779, the engine business was so good that the usually harassed and melancholy Watt wrote to Boulton the only really enthusiastic letter we have from him. The names it mentions are those of a customer and some of his mechanics. The letter says:

Dear Sir,

Hallelujah! Hallelujee!
We have concluded with Hawksbury—£217 pr. annum—from Lady Day last £275 5s. for time past £117 on account. We make them a present of 100 guineas.
Peace and good fellowship on earth—
Perrin and Evans to be dismissed—
3 more engines wanted in Cornwall—
Dudley repentant and amendant—

Yours rejoicing,
James Watt.

At the bottom of the page he adds this shamefaced postscript, "Please burn this nonsense," but Boulton evidently thought it a sufficiently remarkable letter to preserve.

After five years of operation, the engine business began to pay small profits, though the firm was deeply in debt and a new market was becoming essential. Watt wrote to a friend, "Our general expenses have hitherto been very great so that the business never paid its way before 1780, when I guess it got about £2,000 which was all swallowed up in original sin as more must be." Regarding a new market, Boulton wrote to Watt, "We must look out for orders, as all our orders are seemingly at an end, having none now on the tapis. There is no other Cornwall to be found, and the most likely line for increasing the consumption of our engines is in the application of them to mills which is certainly an extensive field." "The people of London, Manchester, and Birmingham are *steam mill mad.* I don't mean to hurry you, but I think that in the course of a month or two we should determine to take out a patent for certain methods of producing rotative motion from . . . the fire engine."

But when Watt finally came to the point of designing rotating shaft engines, unexpected patent difficulties ensued. In August, 1780, a mill owner had secured a patent sufficiently broad to cover the crank-and-connecting-rod method of turning reciprocating motion into rotary motion. Certain records show that one of Watt's workmen, perhaps under the influence of drink, gave his employer's plans away during an ale-house conversation with this competitor's employee. That story is, however, another of the several Watt legends whose details are quite uncertain. A definitely established fact is that Watt angrily refused either to buy the rights to the use of the crank or to risk legal action by using this construction during the life of the patent. Instead,

in the fall of 1781, just a few days after the surrender of Cornwallis at Yorktown, Watt himself patented five different methods of turning reciprocating motion into rotary motion. One of these was a swash-plate mechanism of a type recently unearthed and applied to an oil engine. Another was the interesting sun-and-planet gear which was used by Watt for a dozen years as his standard substitute for the crank.

He described this device in a letter to Boulton in these words: "I have tried a model of one of my old plans of rotative engines. . . . It has the singular property of going twice round for each stroke of the engine and may be made to go oftener around if required without additional machinery." Doubtless a little more description than this is necessary to show the characteristics of the sun-and-planet gear. If one gear (the planet) is pinned rigidly to the connecting rod and is guided by a radial link so it travels around the outside of the crankshaft gear (or sun), the sun and its shaft will be rotated. If the two gears have equal numbers of teeth, the shaft makes two revolutions for one cycle of the planet. If the planet is larger than the sun, the sun will make more than two revolutions for one cycle of the planet, and vice versa.

Practically all of 1782 was spent on rotative engine design and experiment, and in March, 1783, the first engine of this type sold a customer was ready for trial. Once more, the purchaser was John Wilkinson. He wanted this engine to run a trip hammer in his forge shop.

That same year, Watt had another important iron in the fire—the double-acting engine. Until 1783 only half of the steam engine's strokes were power strokes; the other half simply restored the mechanism to its original position. To make each stroke a power stroke had the obvious advantage of doubling the engine's output, but the mechanical changes

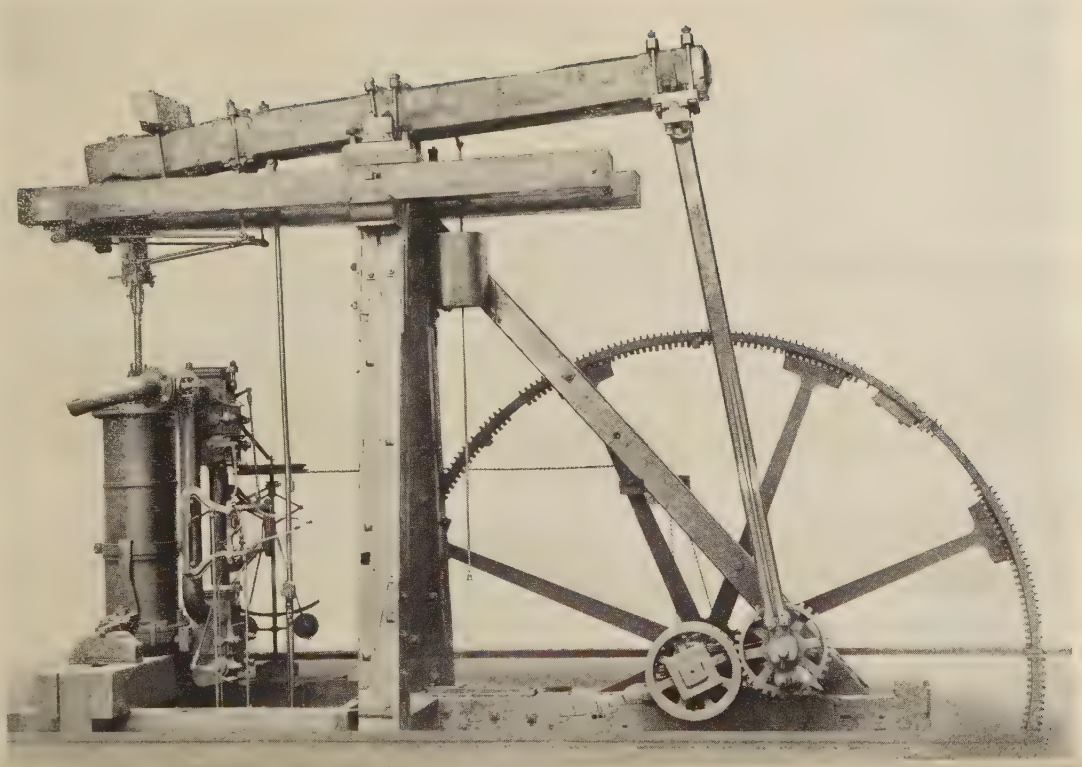
necessary to get this result were not easily made. The chief difficulty lay in guiding the piston in a straight line. As long as the engine was single-acting, the downward pull of the piston was readily kept vertical by means of a short chain fastened to an arc on the beam. This chain was always in tension; but when an upward thrust of the piston was proposed, a different arrangement was obviously necessary. The solution universally adopted today is to fit the piston rod into a crosshead which is forced to follow a straight line by guides. But in 1783 the formation of long smooth straight surfaces such as are needed for guides was a difficult and expensive job. Moreover, the addition of guides to a beam engine greatly increased the engine room's height.

The first double-acting engine Watt built used a rack on the piston rod engaging a gear sector on the beam. Several engines of this type were built in 1783 and 1784; but in June, 1784, Watt wrote Boulton: "I have started a new hare. I have got a glimpse of a method of causing a piston rod to move up and down perpendicularly. . . . If it answers fully to expectation, about five feet in the height of the house may be saved in eight feet strokes. . . . I think it a very probable thing to succeed, and one of the most ingenious simple pieces of mechanism I have contrived." Stated briefly, his idea was this: a vertical link was pivoted in its middle to the end of the piston rod. The upper end of the link was pinned to the beam, and therefore moved through an arc centered in the beam bearings; but the lower end was pivoted through a horizontal lever to the engine room wall and therefore swung in an arc opposite to that of the beam. By making the length of the horizontal lever half the length of the beam, the upper end of the piston rod was guided in approximately a straight line. This device worked well, but it had the disadvantage of requiring extra room for

the long horizontal lever. Almost immediately Watt discovered that this length could be decreased if he pinned the piston rod above the middle of the vertical link; but in a very few months another improvement occurred to him. By hanging from the beam a parallelogram of jointed links and by attaching the long lever to it near the beam bearings, he evolved the very compact mechanism known as the parallel motion. It had the added advantage of giving almost straight line motion to the air-pump piston rod, which operated the steam valves through tappets.

These two improvements of double-acting and rotary shaft operation gave Watt an engine which could be applied to drive practically any sort of machine of his day. Orders from flour mills, breweries, and iron mills crowded the facilities of Boulton and Watt to the utmost, and the mines also began using rotating engines for hoisting purposes. In fact, new uses for the steam engine continued to appear in all these fields for over a hundred years, to stop only when the convenience of interposing the electric motor between the prime mover and the driven machinery halted the direct application of engine drive to factories. Profits for the engine builders were soon so good as to take financial worries off of Watt's mind permanently.

But the mechanical design of the engine still required much attention. The massive beam was always an expensive part of the engine, and making the cylinder double-acting required strengthening this part. For single-acting engines, it was often 30″ by 30″ by 24 feet long, of the best oak timber. In 1784 it cost perhaps £600. For double-acting engines, kingposts and stays were often added at first; but by 1800, cast iron beams began to be used, and ten years later they were always applied. The mechanism operating the two steam and two exhaust valves was also improved.



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Another of Watt's activities of 1782 and 1783 helped put his name into the mouth of every user of electricity or steam power. This was his determination of the horsepower. Savery and other men had described the working capacity of Newcomen engines in terms of the number of horses displaced by the engine, a unit which though highly indefinite seemed at that time entirely natural as to name and size. But no one had attempted to define the power of a horse until in 1782 Watt adopted the figure 32,400 ft. lbs. per minute. Later he switched to the figure 33,000 ft. lbs. per minute which is universally used today. It is based on the observed ability of a brewery mill-horse to walk at two and a half miles an hour while raising 150 lbs. tied to a rope running over a pulley.

The horsepower continued to be the standard unit of power output until 1889, when the need for an electrical unit of power was apparent. In that year, the International Electrical Congress defined such a unit and gave it and its larger commercial unit the names watt and kilowatt, thus putting Watt's name frequently on the tongue of all civilized people. In that way, the Congress erected to him a monument much more durable than stone or bronze—possibly one even more enduring than the reciprocating steam engine itself.

The last of Watt's engine inventions of primary importance appeared in 1788, when he applied to an engine in Boulton's factory his rotary governor for producing constant speed at the engine's crankshaft. This engine stands today in the Science Museum at London, the first engine to be made complete with all the major contributions of Watt to the steam engine, i.e. the separate condenser, the double-acting cylinder, the parallel motion, steam expansion, the sun-and-planet gear, the flyball governor. The governor

was an immediate success, and once more a shower of orders descended upon the hard-pressed factory.

Some time in the next two years, Watt is thought to have invented the steam engine indicator, a device in universal use today in determining the behavior of fluids in engine cylinders. It is essentially a pressure gauge which makes a graphic record of pressure changes on a paper chart moved in step with the engine's piston. So valuable was this instrument that Watt kept its existence secret for many years; hence we are unable to tell just how much of the invention was Watt's and how much was due to his chief draftsman John Southern, whom he hired on the peculiar condition that Southern give up his interest in music, which Watt insisted would have a bad effect on his engineering activities. Some forty years later, another Glasgow instrument maker, John McNaught, invented the oscillating drum now always used in place of Southern's reciprocating carriage.

During the hectic twelve years between 1775 and 1787, when Watt was placing before a greedy world the inventions just described, he was far from lacking in general social and scientific interests. For example, he belonged to a Birmingham club of kindred spirits known as the Lunar Society, so called because they always met for dinner and scientific discussions on the Monday nearest the full moon. Some of their number, like Josiah Wedgwood the potter and Dr. Erasmus Darwin, lived outside the city and presumably they wished the moonlight to help them get home. One distinguished member of this group was Dr. Priestly, the discoverer of oxygen and some eight other gases. Another, Dr. Darwin, the grandfather of the naturalist Charles Robert Darwin, was the author of *The Botanic Garden,* a book of verses very popular in his day. It was he who wrote this alliterative prophecy:

Sketch made from
plate on
"CLERMONT"

STEAM 25"
VAC. 24"
REV 12

The Draught indicator

FROM A. G. LIPPINCOTT,
NEWARK, N. J.

> Soon shall thy arm, unconquered steam, afar
> Drag the slow barge or drive the rapid car;
> Or on wide waving wings extended, bear
> The flying chariot through the fields of air.

To this group, Watt presented in 1783 a discussion of the constitution of water. At his friend's suggestion, he prepared his theory in a paper which Dr. Priestly was to present for him to the Royal Society; but delays in collecting experimental data allowed Cavendish to present his results first and to receive credit in many quarters for discovering that water was made of oxygen and hydrogen. There is, however, even today some difference of opinion as to whether Watt or Cavendish should have credit for discovering this fact. Watt always thought that the honor should be his.

By 1794, when Watt was fifty-eight years old, he was able to retire gradually from the engine business, placing its control in the very capable hands of a son of Boulton and a son of Watt. These two young men soon began the modern practice of making the complete engine in their factory and selling it for a fixed sum. Eight years after Watt's retirement, the firm built a horizontal double-acting engine which drove the paddle wheel of the first British steamboat, a tug-boat which was not a commercial success. In 1807, twelve years before the death of James Watt, one of their customers was Robert Fulton, whose steamboat "Clermont" was powered by a nineteen horsepower Boulton and Watt engine with a cylinder twenty-four inches in diameter by four feet stroke. Thereafter the firm became very busy in the new and profitable field of marine engine building.

Watt's later years were spent in a most interesting period in which to live—a time of rapid growth strikingly comparable to the past thirty years. In place of our World War we can put the Napoleonic conflicts; in place of the Russian,

German, and Italian Revolutions we can put the French and American Revolutions; in place of our modern manufacturing and scientific men we can nominate several score pure scientists like Davy and Charles and as many pioneers of the Industrial Revolution like Eli Whitney and Arkwright.

In all these changes Watt took a quiet interest. Unlike so many inventors who lacked a Matthew Boulton to love them and pull them up to success, Watt received both financial and social recognition of his contributions to civilization long before the end of his life. Sir Walter Scott describes him in 1817 in these words: "In his eighty-fifth year, the alert, kind, benevolent old man had his attention alive to every one's question, his information at every one's command.

"His talents and fancy overflowed on every subject. One gentleman was a deep philologist,—he talked with him on the origin of the alphabet as if he had been coeval with Cadmus; another, a celebrated critic,—you would have said the old man had studied political economy and belles-lettres all his life,—of science it is unnecessary to speak, it was his own distinguished walk . . . , we discovered that the gifted man of science was . . . as shameless and obstinate a peruser of novels as if he had been a very milliner's apprentice of eighteen."

Certainly a quiet interested old age was no more than Watt deserved from the world he had served so well. The social and economic results of his inventions are so vast as almost to prevent description. How can a civilized person of today avoid the influences of steam machinery? Perhaps this might be done by moving deeply into jungles and arctic wastes, but how many of us wish to abandon the creature comforts and the mental satisfactions of today's civilization? Matthew Boulton was entirely right in telling Dr.

Johnson's friend Boswell: "I sell here, sir, what all the world desires to buy,—POWER." This power is, of course, the reason why modern nations risk serious wars for the sake of coal and oil deposits; and it was Watt's key which unlocked the tremendous supplies of energy latent in these fuels.

One way of appreciating the value of that key is to imagine the effects of its sudden loss. To take away Watt's contributions to steam engineering would practically deprive us of electricity and of liquid fuels and would make most of our machinery worthless. It would put us in a very painful way back into the material civilization of George Washington—back into the days of the tallow candle and the treadmill, for without power from fuel how could we secure large quantities of electricity for lamps or motors?—back into the days of stage coach and sailing ship, when journeys took weeks instead of equal numbers of days, and when there was good reason for inaugurating a president of the United States four months after election day; back into the days of handcrafts and cottage industries, when clothing was handwoven, handmade, and expensive, when twelve hours was a fair working day and seven years a common term of apprenticeship, when the family of a skilled workman lived in two or three rooms, on a limited diet conspicuously free from the influence of refrigeration, when printing and papermaking were done by hand and newspapers contained one or two sheets; back, doubtless, to a thinner population and a shorter length of human life.

It may be argued that outside of railroad service the reciprocating steam engine is no longer our chief source of power. It is true that tremendous amounts of the horsepower supporting our civilization come from steam turbines or internal combustion engines; but without the reciprocat-

ing steam engine we should hardly have developed these its more complex rivals. For over a century, during which time our manufacturing and electrical developments were worked out, the steam engine was the giant of prime movers and the mainspring of industry and transportation. Without its aid, many of our industries and many of our nations would still be unborn. Whatever its ultimate future may be, one cannot deny that its inventor laid one of the largest foundation stones beneath today's and tomorrow's machine-supported civilization.

J. H. Pound.

V

THE CONSTITUTION OF ATOMIC NUCLEI

THE modern chemical theory of atoms was proposed by John Dalton early in the nineteenth century. During that century atoms were thought of as very small indivisible hard particles. In 1897, Sir J. J. Thomson discovered electrons, which are small particles of negative electricity much lighter than atoms, and it was found that atoms contain electrons and so are not indivisible particles. In 1911, Lord Rutherford suggested that atoms consist of a minute, heavy particle or nucleus much smaller than the atom with electrons moving about outside the nucleus. According to this nuclear theory an atom is like the solar system. The sun and its planets are like the nucleus with the electrons moving round it.

Nearly all the weight of an atom is in the nucleus, the electrons only account for about one four-thousandth part of the weight.

The relative weights of the atoms of different elements are known accurately. They have been determined experimentally by several independent methods which give practically identical results. Table I gives the atomic weights of several elements, taking that of oxygen to be 16. These atomic weights are all nearly whole numbers, which suggests that the atoms are built up out of particles of atomic weight approximately unity. It is customary now to regard atoms as compounds of neutrons and ordinary hydrogen atoms, which both have atomic weights slightly

TABLE I

ATOMIC WEIGHTS

Neutron	1.0083	Beryllium	8.0071
Hydrogen	1.0079	Beryllium	9.0137
Hydrogen	2.0141	Beryllium	10.0149
Hydrogen	3.0162	Boron	10.0141
Helium	3.0170	Boron	11.0112
Helium	4.0033	Carbon	12.0037
Lithium	6.0162	Nitrogen	14.0075
Lithium	7.0170	Oxygen	16.0000

TABLE II

ELEMENT	SYMBOL	NEUTRONS	PROTONS	ELECTRONS
Electron	$\bar{e}$	0	0	1
Neutron	${}_0n^1$	1	0	0
Hydrogen	${}_1H^1$	0	1	1
Hydrogen	${}_1H^2$	1	1	1
Hydrogen	${}_1H^3$	2	1	1
Helium	${}_2He^3$	1	2	2
Helium	${}_2He^4$	2	2	2
Lithium	${}_3Li^6$	3	3	3
Lithium	${}_3Li^7$	4	3	3
Beryllium	${}_4Be^8$	4	4	4
Beryllium	${}_4Be^9$	5	4	4
Beryllium	${}_4Be^{10}$	6	4	4
Boron	${}_5B^{10}$	5	5	5
Boron	${}_5B^{11}$	6	5	5
Carbon	${}_6C^{12}$	6	6	6
Carbon	${}_6C^{13}$	7	6	6
Nitrogen	${}_7N^{14}$	7	7	7
Nitrogen	${}_7N^{15}$	8	7	7
Oxygen	${}_8O^{16}$	8	8	8
Oxygen	${}_8O^{17}$	9	8	8

greater than 1. The neutron is a recently discovered particle which is electrically neutral.

The nucleus of an atom of ordinary hydrogen is called a proton, and it may be regarded as a particle of positive electricity. The positive charge of a proton is equal to the negative charge of an electron, and an atom of ordinary hydrogen consists of one proton with one electron moving round it. The proton and the electron attract each other just as the sun and a planet do. The nuclei of atoms are built up out of neutrons and protons, and the number of electrons outside the nucleus is equal to the number of protons inside it. There are no electrons inside the nucleus. Table II gives the numbers of neutrons, protons, and electrons in the atoms of the elements in Table I.

The chemical properties of an atom are determined by the number of electrons it contains so that, for example, the three different sorts of beryllium atoms with atomic weights approximately 8, 9, and 10, respectively, all contain four electrons and so all have the same chemical properties and are therefore regarded as atoms of the same element, beryllium, although they have different weights. The number of protons or electrons in the atom of an element is called the atomic number of the element. In the same way we have three sorts of hydrogen atoms with atomic weights approximately 1, 2, and 3, but all with the atomic number 1.

The weight of an atom is always slightly less than the sum of the weights of the neutrons, protons, and electrons which it contains. Since the number of protons is always equal to the number of electrons, we may regard the atoms as made up of neutrons and of hydrogen atoms each containing one proton and one electron. The helium atom of atomic weight 4.0033 contains two neutrons and two hydrogen atoms, the total weight of which is 4.0324, thus:

$$2\times 1.0083 = 2.0166$$
$$2\times 1.0079 = \underline{2.0158}$$
$$\underline{4.0324}$$

The loss of weight in this case is therefore the difference

$$4.0324$$
$$\underline{4.0033}$$
$$\underline{0.0291}$$

In the same way for oxygen ${}_8O^{16}$ we have

$$8\times 1.0083 = 8.0664$$
$$8\times 1.0079 = \underline{8.0632}$$
$$\underline{16.1296}$$

so that there is a loss of 0.1296, since the atomic weight of oxygen is exactly 16.

In ordinary chemical reactions the total weight of the products formed is always equal to that of the materials used up, so that there is no loss of weight, or at least the loss of weight is so small that it cannot be detected. It is therefore clear that the hypothetical formation of atoms by the combination of neutrons and hydrogen is a very different process from ordinary chemical combination.

According to Einstein, energy has weight, and it is believed that the loss of weight when atoms are formed out of neutrons and hydrogen is due to the emission of energy. An atom has less total energy than the neutrons and hydrogen atoms out of which it was formed, and so has less weight. The loss of weight is therefore a measure of the energy of formation.

The amounts of energy involved are very large. For example, if sixteen pounds of oxygen were formed by the combination of neutrons and hydrogen, the energy set free

would weigh 0.1296 of a pound, or a little more than two ounces. This amount of energy is equivalent to more than two hundred thousand horse-power for one year. At one cent a kilowatt hour it would be worth about fifteen million dollars. It is possible that before our oil has been exhausted methods will be discovered for making available the energy of formation of atoms for commercial purposes. This will require the transmutation of elements with low energies of formation into elements with higher energies of formation, so setting free the difference. The science of the transmutation of the elements is a very recent growth and may be expected to develop rapidly. In the long run the study of the constitution of atomic nuclei may be expected to be profitable, just as so many other branches of pure science have proved to be.

The energies of formation of the elements in Table I are given in Table III. They were calculated by subtracting the atomic weight of the atom from the total atomic weights of the neutrons and hydrogen atoms out of which the atom is formed, so getting the loss of atomic weight. These losses are nearly multiples of a constant equal to 0.000415, and so may be conveniently expressed in terms of this quantity

TABLE III

ENERGIES OF FORMATION

(In terms of 0.000415 atomic weight units as unit)

Hydrogen	$_1H^2$	5	Beryllium	$_4Be^9$	143
Hydrogen	$_1H^3$	20	Beryllium	$_4Be^{10}$	160
Helium	$_2He^3$	17	Boron	$_5B^{10}$	161
Helium	$_2He^4$	70	Boron	$_5B^{11}$	188
Lithium	$_3Li^6$	78	Carbon	$_6C^{12}$	225
Lithium	$_3Li^7$	96	Nitrogen	$_7N^{14}$	255
Beryllium	$_4Be^8$	139	Oxygen	$_8O^{16}$	312

as unit. The energies of formation are proportional to the loss of atomic weight, and so may be expressed in terms of the same unit.

The energies of formation represent the work done by the forces of attraction between the neutrons and protons when they combine together to form the atomic nucleus. It is supposed that these particles attract each other strongly when they are very near together or actually in contact. When two particles are connected together by the attraction between them, we may say that a bond or connection has been formed between them, and we may suppose that the formation of such a bond always involves the liberation of a definite amount of energy. On this view the energy of formation of a nucleus should be equal to the sum of the bond energies of the bonds formed in the nucleus. There are three different sorts of bonds which may be formed, namely, bonds between two protons, bonds between two neutrons, and bonds between a neutron and a proton. To account for the energies of formation we may try to find bond energies and arrangements of the neutrons and protons in the nucleus such as to give the correct energies of formation. I have found that taking the energy of a proton-proton bond equal to 21, that of a neutron-neutron bond equal to 9, and that of a proton-neutron bond equal to 10, makes it possible to find arrangements of the neutrons and protons giving the

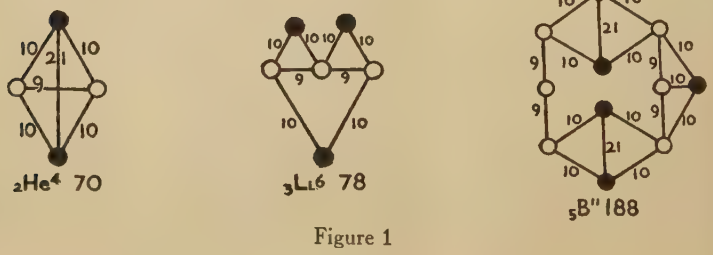

Figure 1

correct energies of formation. Figures 1 and 2 show such arrangements for several atoms. The black disks represent a proton and the circles a neutron. The lines connecting the neutrons and protons represent the bonds between them, and the numbers at each line are its energy of formation. The sum of the bond energies gives the energy of formation, and the sums agree with the values given in Table III. In this way we obtain possible arrangements and bond energies, but we do not know if the arrangements chosen are the actual

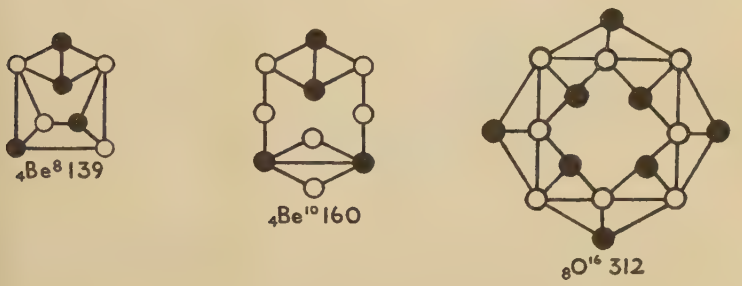

Figure 2

ones. Different arrangements with different bond energies might also give the correct energies of formation.

During the past fifteen years many cases of the artificial transmutation of one element into another have been discovered. The first such transmutation was discovered by Lord Rutherford in 1919. These transmutations, or nuclear reactions, as they are called, occur when a particle, such as a proton, moving with high velocity collides with an atom. The proton enters the nucleus of the atom, combining with it. The nucleus then disintegrates or explodes, emitting a particle which is not the same as the particle which previously combined with it. The atomic weight of the nucleus is thus altered, and it is changed into the nucleus of a different atom. For example, a lithium atom of atomic weight 7

can combine with a proton forming a new atom of atomic weight 8 which then disintegrates into two helium atoms each of atomic weight 4. This nuclear reaction may be represented by the equation

$$_3Li^7 + _1H^1 \rightarrow {}_2He^4 + {}_2He^4$$

Figure 3 shows how the neutrons and protons may be supposed to be rearranged in this reaction. The bonds in the

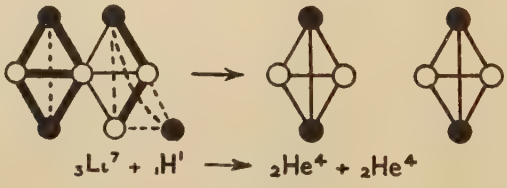

Figure 3

lithium atom which remain unchanged are represented by thick lines, the new bonds to be formed by dotted lines, and the bonds which disappear by thin lines. A very similar transmutation occurs when a boron atom combines with a proton and then disintegrates into three helium atoms. This

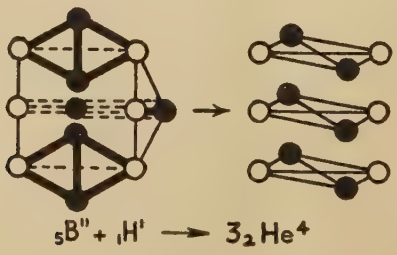

Figure 4

is shown in Figure 4. When boron $_5B^{10}$ combines with a neutron, we get the transmutation into lithium and helium shown in Figure 5. The boron $_5B^{10}$ after combining with the

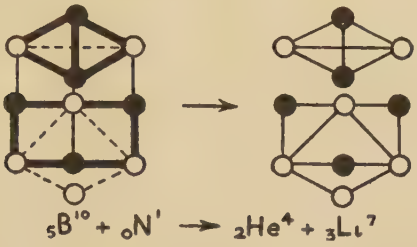

Figure 5

neutron may also disintegrate into two helium atoms and one hydrogen atom of atomic weight 3. Another nuclear reaction is shown in Figure 6. Oxygen combines with hydrogen of atomic weight 2 and then disintegrates into nitrogen and helium. These examples are perhaps sufficient to show that the assumed nuclear constitutions are compatible with the observed nuclear reactions or transmutations. All known

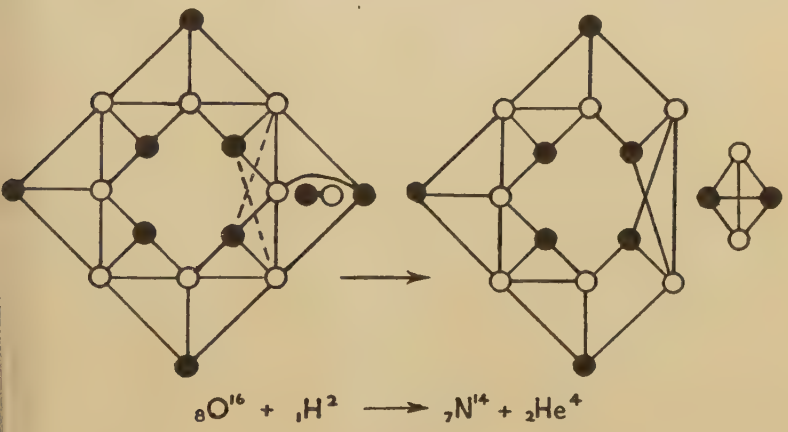

Figure 6

nuclear reactions involving the elements considered can be represented in a similar way.

The atoms formed in nuclear reactions sometimes have more than the normal amount of energy, which means that some of the bonds of the normal atom are absent or have

less than the normal energies of formation. For example, the atom of hydrogen $_1H^2$ has energy of formation 5 instead of the normal value 10 for a bond between a neutron and a proton. The atom of helium $_2He^4$ is sometimes formed with energies of formation 40 or 30 instead of the normal value 70. Atoms with less than the normal energy of formation are called excited atoms, and such atoms usually emit radiation with energy equal to the difference between the normal energy of formation and their lower energy of formation and so change to normal atoms. The helium atom with energy of formation 30 changes to one with 40 emitting radiation with energy 10, and then changes to a normal atom emitting radiation with energy 30.

The suggested nuclear constitutions, therefore, appear to be supported by the evidence at present available, but, of course, they may require modification as new facts are discovered. In such a recently developed branch of physics, final conclusions are not to be expected for a long time.

The further study of nuclear reactions may be expected to result in the determination of the constitutions of the nuclei of the elements of higher atomic weights. Such knowledge should be of great value, and nuclear reactions are being studied experimentally in several laboratories in this country and in Europe. Unfortunately, the equipment required for such work is very elaborate and costly, so that laboratories where ample funds are available have a great advantage over those with limited resources.

H. A. Wilson.

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